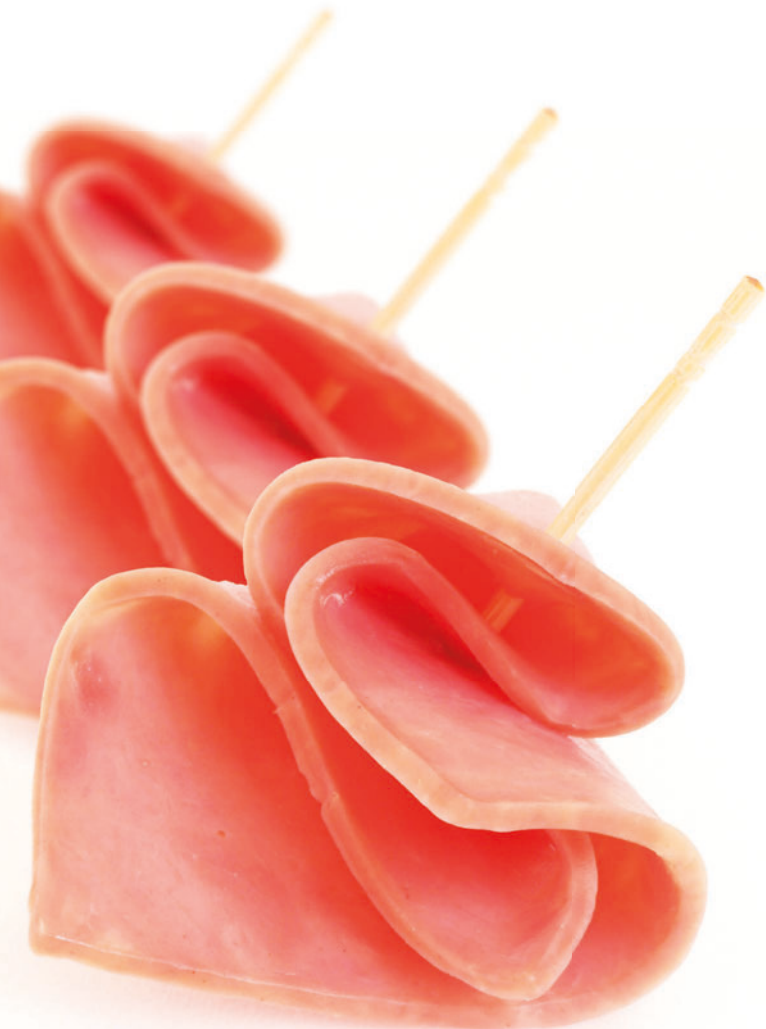


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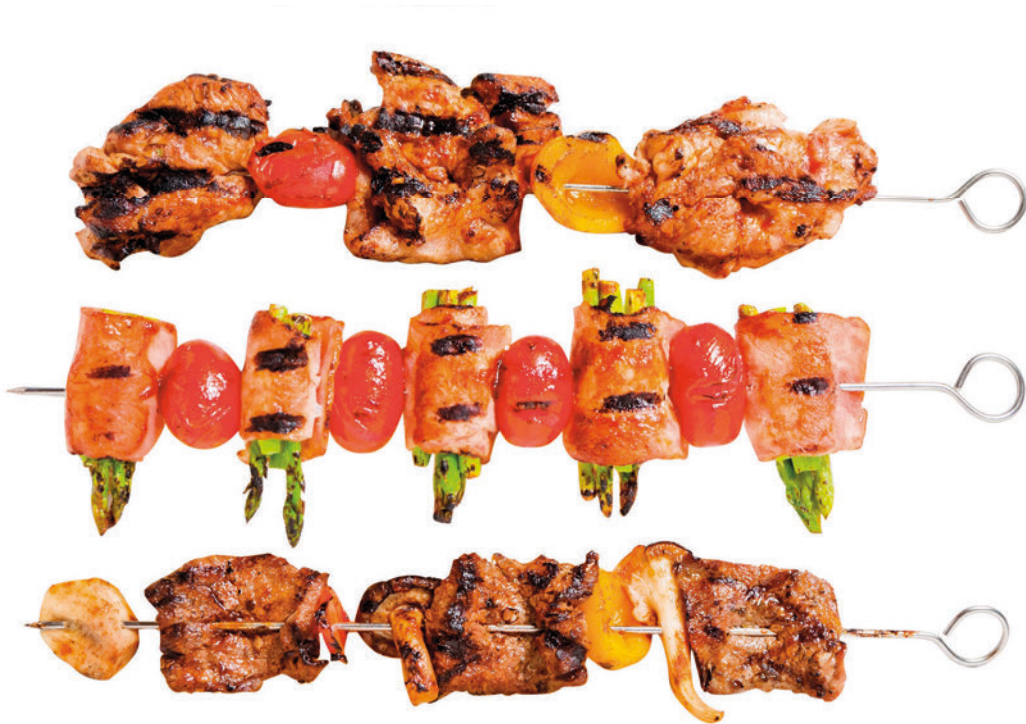
Sodium reduction made easy
with sub4salt[®] cure and
potassium lactates

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Introduction

There are two important considerations in the preparation of processed meat products. Firstly, a product that remains safe and stable for its entire shelf life is a must. Secondly, there is an increasing demand for healthier meat products. One of the major health trends in the processed meat market is sodium reduction, since these products usually contain high levels of salt. A high sodium intake is associated with negative effects on the human body such as hypertension, strokes and kidney disease.



Potassium lactate and blends with acetates or diacetates accommodate both of these considerations. SALT Minerals provides solutions for the meat industry that ensure there is no microbiological growth in products over a long period of time, even at low use levels. Furthermore, choosing the right potassium-based ingredient can result in a sodium reduction of over 25% and, in combination with SALT Minerals's sub4salt® cure, a 1:1 curing salt substitute, a sodium reduction of over 50% is possible.

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Why reduce sodium?

Changing lifestyles and rapid urbanization have caused a shift in dietary patterns to consuming more highly processed food and further from a diet focusing on fresh fruits and vegetables. Processed food is not only usually more calorie-dense and high in saturated fats, trans fats, sugars and salt, but also lower in potassium as this highly soluble mineral is washed out during processing.^[20]

Due to the reasons above, arteriosclerosis and hypertension are common in the modern Western world leading to cardiovascular diseases (CVD).^[1-6] A diet high in sodium and low in potassium raises blood pressure and increases the risk of heart disease and stroke. According to the WHO, 2.5 million deaths could be prevented each year if the global sodium consumption would be reduced to the recommended value of max. 2 g per day which corresponds to 5 g of salt per day.



Globally most people consume an average of 9-12 g of salt per day, which is twice as much as the general recommendation. Additionally, the potassium intake is lower than the recommended value of 3.5 g per day which can further increase blood pressure. The reduction of sodium has been identified as one of the most cost effective measures countries can take to improve population health.^[20]

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The functionality of salt in processed meat

Table salt is not the main source of sodium in the human diet: 80% of our sodium intake actually comes from processed food (graph 1). After baked goods, processed meat products contribute to the highest sodium intake of any single group, due to the quantity of salt traditionally added during preparation. Table 1 shows the typical sodium content of raw and processed meats. It is noteworthy that the natural sodium content of meat is very low compared to that of processed meat products.

Graph 1: Proportional contribution of processed foods to salt intake: DE Data

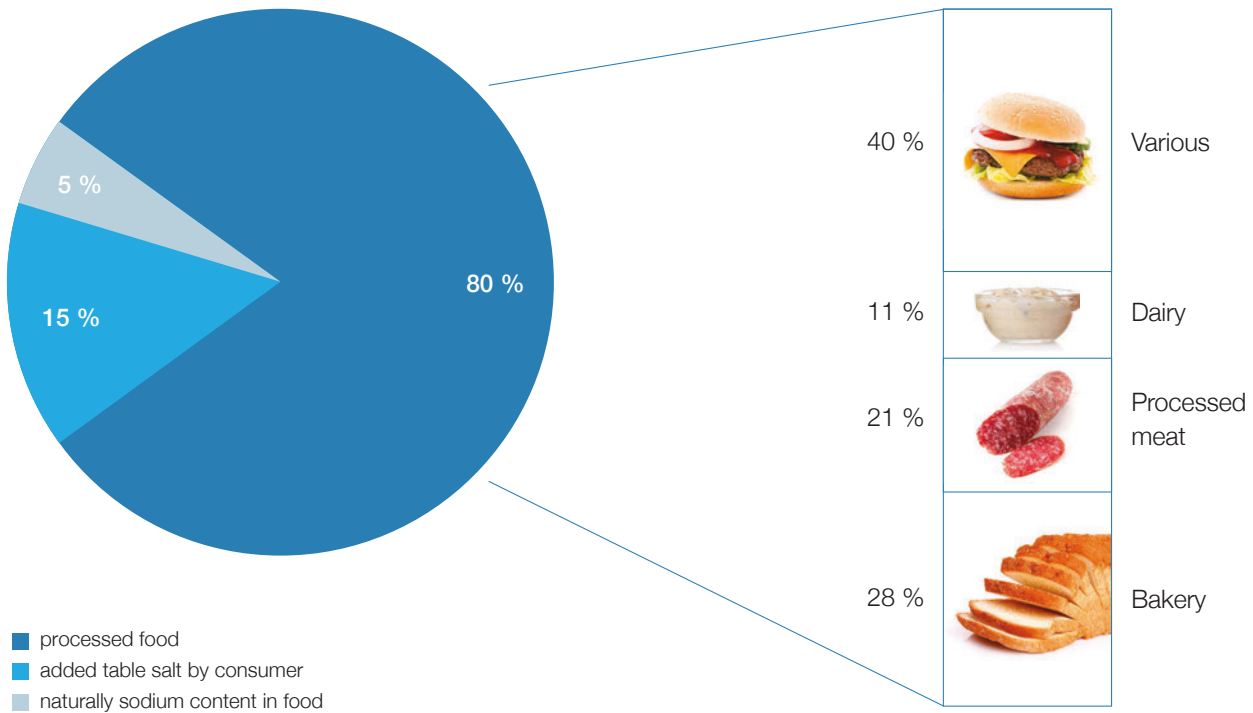


Table 1: Sodium content of meat products

Product	Sodium content [mg/100 g]
Beef	63
Pork	70
Chicken	60
Turkey	50
Pork sausage	600-1,080
Frankfurters	720-1,120
Cooked ham	900-1,200
Beef bologna	1,080
Cured ham	1,500
Corned beef	1,220
Salami	1,800-1,900



There has been a long tradition of using salt in the preparation of meat products. While taste is the main reason for adding salt to meat, salt also has an important function as a preservative since meat is very sensitive to microbial spoilage. Without appropriate treatment, the raw meat degradation process is very rapid. Curing meat is a method that has been used for centuries. Curing salt, a combination of sodium chloride and sodium nitrate or sodium nitrite, helps to maintain the meat's red colour and retards microbial growth.

Consumers are looking for appetising products with a long shelf life. Therefore, processed meat products need further treatment to meet modern quality standards on food safety and stability. For example, the use of sorbate and benzoate is one efficient way of suppressing microbiological growth. But these preservatives are artificial substances which do not fit well with the consumer's drive towards natural ingredients. Lactates and blends with acetates or diacetates are derivatives of lactic acid and constitute a perfect alternative, as this organic acid with antibacterial properties is a product of the natural process of fermentation. Furthermore, lactic acid and lactates occur naturally in the human body, being important intermediates and products of the metabolism. Many food products naturally contain lactic acid. In fermented foods such as sauerkraut and olives, lactic acid provides the typical taste profile and guarantees product stability.

Performance of potassium lactate and blends in processed meat products

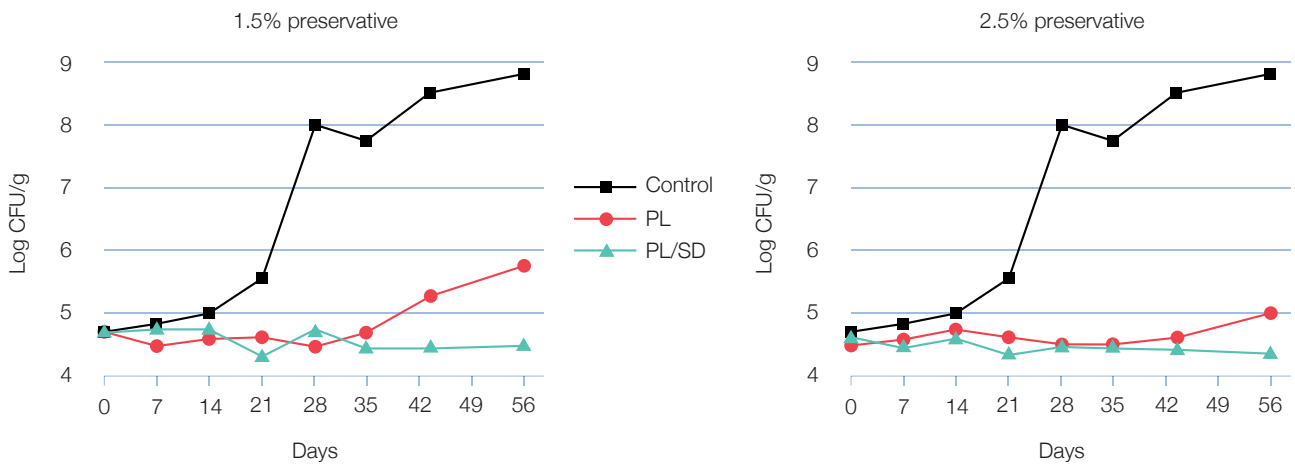
Listeria control and shelf life extension

The main reason for the use of lactates and blends with acetates or diacetates in processed meat products is their bacteriostatic properties. As they provide excellent microbial growth inhibition, the product remains safe and stable throughout its shelf life. Different tests have been performed to evaluate the efficacy of potassium lactate 60% (PL) and potassium lactate/sodium diacetate 56%/4% (PL/SD) against *Listeria monocytogenes* and aerobic mesophilic bacteria. These microbiological species were chosen as they represent typical and critical bacteria that occur in processed meat products. *Listeria monocytogenes* is a dangerous pathogen that leads to serious food poisoning. The meat industry is still confronted with deaths caused by this specific germ.^[19] Aerobic mesophilic bacteria are an indicator for meat product spoilage and the growth inhibition of this type of microorganisms guarantees a stable product throughout its targeted shelf life.

The tests were performed using a cooked lyoner/bologna-type sausage formulation containing 2% standard curing salt. The preservatives were added to the sausage meat at different concentrations to determine differences in efficacy. After cooking, the sausages were sliced. These slices were then inoculated with 10^4 CFU/g of *Listeria monocytogenes* and stored at 7°C for 56 days. Microbiological growth was analysed at specific points in time (0; 7; 14; 21; 28; 35; 44; 56 days).

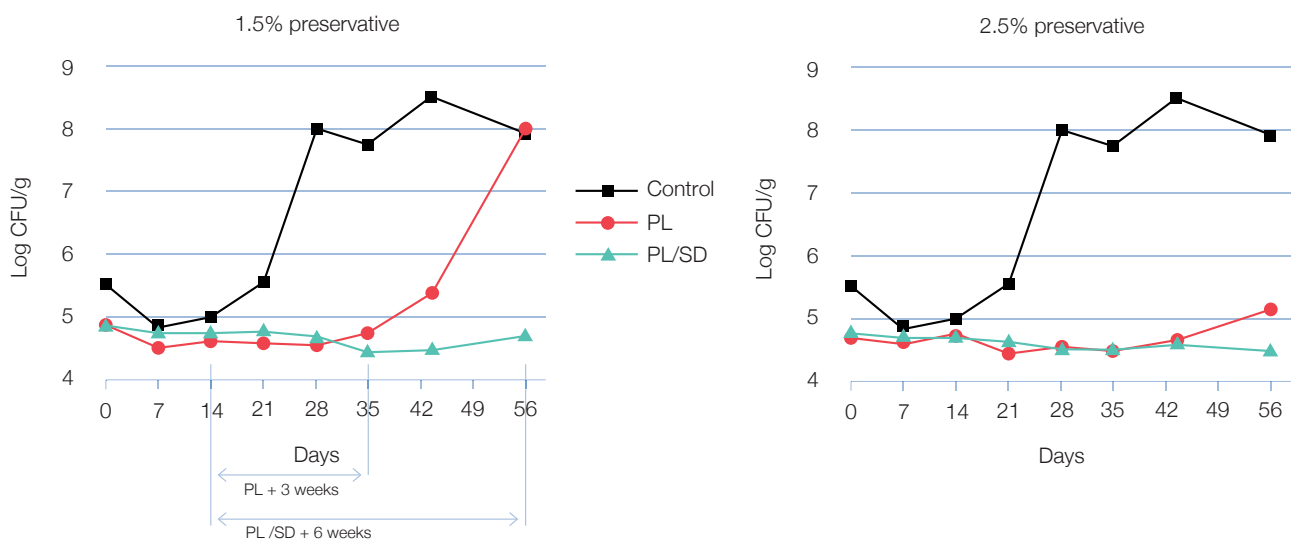
Graph 2 shows the effects of 1.5% and 2.5% potassium lactate and potassium lactate/sodium diacetate on *Listeria monocytogenes* growth inhibition. It can be seen that, under these conditions, microbial growth starts on sausages without additional preservatives after storage day 14. With a preservative concentration of 2.5%, there is almost no growth for either formulation during the entire test period. Slight growth can be seen after storage day 44 on sausages containing PL only. With a preservative concentration of 1.5%, there is no microbial growth in formulations containing PL/SD during the entire test period. In sausages containing PL as a single substance, microbial growth starts after storage day 35. This means the PL/SD blend provides the same product stability at both the lowest and highest use levels tested.

Graph 2: Growth inhibition of *Listeria monocytogenes* with 1.5% and 2.5% preservative



For the aerobic mesophilic bacteria, the results are quite similar (graph 3). After day 14, there is microbial growth on products without preservatives. At 2.5% use level, slight growth starts after day 44 on formulations containing PL whereas no growth can be observed on formulations containing PL/SD. At a 1.5% preservative use level, the effect is more marked, with a significant difference in the performance of the two preservatives. In the sausages containing PL, bacterial growth resumes after storage day 35 and increases rapidly, reaching the level of the preservative-free control by the end of the test period. With PL/SD at 1.5%, again no growth is detectable during the entire storage period. Compared to control, a shelf life increase of three weeks can be achieved with the use of PL as a single substance at 1.5%. The same PL/SD use level allows an additional six weeks of shelf life compared to control, underlining the advantages of blends of potassium lactate with diacetates. The additional antimicrobial effect of diacetate means that a reduced amount of the blend is needed to achieve the same product stability as with lactate alone. A use level of 1.5-1.75% of blends containing 56% potassium lactate and 4% sodium or potassium diacetate is advisable (prior testing is always recommended before defining the final dosage in the meat product to be commercialised). The 30-40% lower use levels of the blends vs. the straight lactates result in cost savings without compromising on performance.

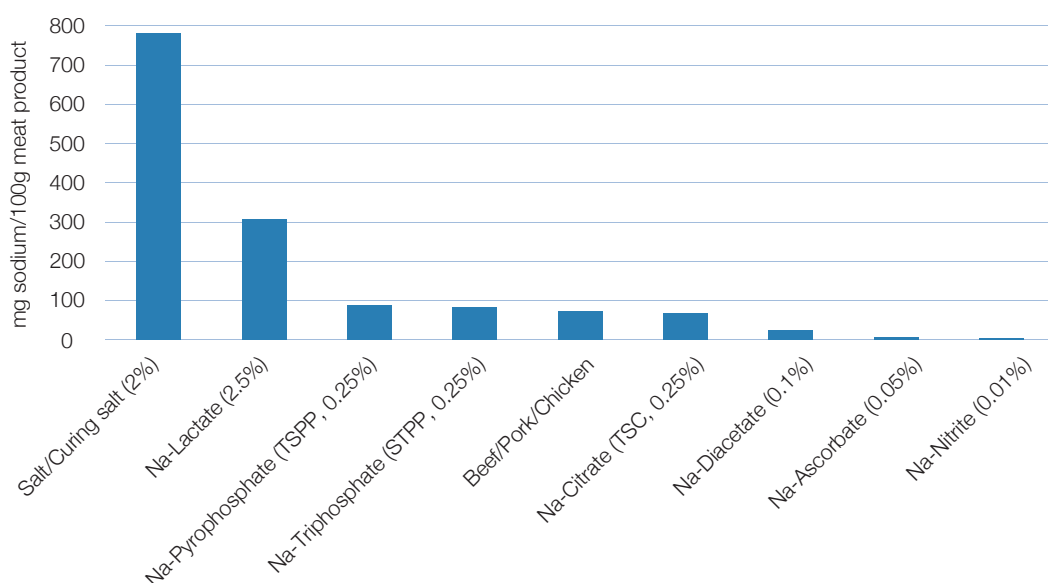
Graph 3: Growth inhibition of aerobic mesophilic bacteria (total plate count) with 1.5% and 2.5% preservative



From 25% to over 50% sodium reduction

Graph 4 shows the main sources of sodium in processed meat products. The natural sodium content of meat is quite low, but a 2% addition of salt or curing salt increases the sodium content by nearly 800 mg per 100 g. The second highest sodium input comes from sodium lactate. For effective preservation, 2.5% of sodium lactate 60% is normally used, increasing the sodium level by 300 mg per 100 g. Other ingredients such as phosphates, citrates and diacetates play a minor role in terms of additional sodium in meat products. Reducing sodium in salt, curing salt and sodium lactate is the key to reducing total sodium in processed meats.

Graph 4: Sodium sources in meat products



The combination of 2.5% of sodium lactate 60% and 2% standard curing salt adds 1100 mg of sodium per 100 g of the end product (table 2). Replacing sodium lactate with potassium lactate will achieve sodium reduction levels of over 25%. The same reduction will be achieved by using potassium-based lactate/diacetate or lactate/acetate blends at a suggested use level of 1.75%.

As an alternative to salt, SALT Minerals has developed a 1:1 substitute containing 35% less sodium. This product, called sub4salt®, is a blend of sodium chloride, potassium chloride and sodium gluconate. For use in meat products sub4salt® has been combined with sodium nitrite to provide the first sodium reduced, ready-to-use curing salt substitute. sub4salt® cure provides the same functions as standard curing salt and is easy to handle by replacing standard curing salt 1:1. SALT Minerals offers sub4salt® cure in two types to meet the different requirements of meat processors: sub4salt® cure 05 with 0.5% of sodium nitrite and sub4salt® cure 09 with 0.9% of sodium nitrite.

Combining potassium lactate or potassium lactate/(di)acetate blends with sub4salt® cure allows to reach unheard sodium reduction levels of over 50%, without compromising taste, texture and microbiological stability (table 2).

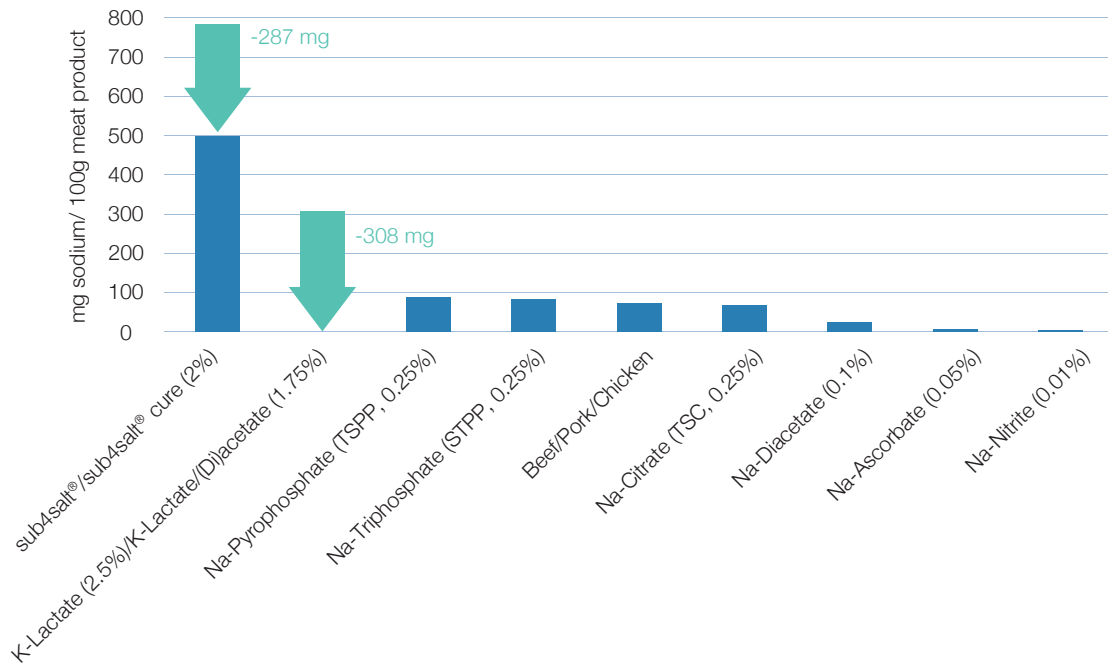


Table 2: Sodium contribution per 100 g cooked ham of different lactates and lactate/(di)acetate blends in combination with standard curing salt and SALT Minerals sub4salt® cure

Product	2 % curing salt	2 % sub4salt® cure
2.50 % Sodium Lactate	1100 mg Na	810 mg Na (-26 %)
2.50 % Potassium Lactate	790 mg Na (-28 %)	500 mg Na (-54 %)
1.75 % Potassium Lactate / Sodium (Di)acetate	800 mg Na (-27 %)	510 mg Na (-53 %)
1.75 % Potassium Lactate / Potassium (Di)acetate	790 mg Na (-28 %)	500 mg Na (-54 %)

Graph 5 shows the reduced sodium levels in processed meat products after switching from standard curing salt to sub4salt® cure (-287 mg per 100 g) and from sodium- to potassium-based lactates or lactate/(di)acetate blends (-308 mg per 100 g).

Graph 5: Impact of the replacement of salt or curing salt by sub4salt® or sub4salt® cure, and of sodium lactate by potassium lactate or blends thereof with (di)acetates on the contribution of sodium sources in meat products



Sensory evaluation

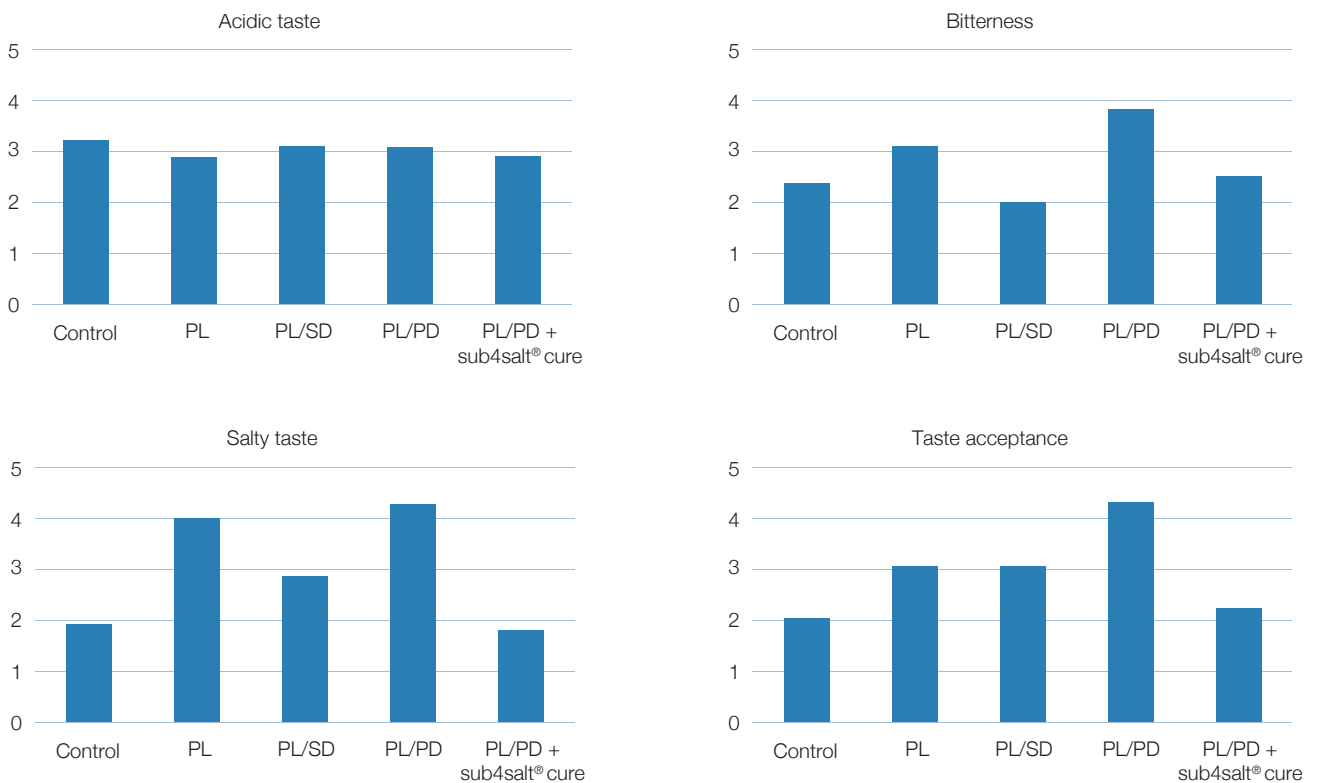
Products containing a higher level of potassium salts are thought to have a bitter aftertaste. To assess the potential impact on taste, a sensory panel consisting of 19 to 22 panellists tested standard cooked sausages with different preserving ingredients. This sensory evaluation tested specific attributes of lyoner/bologna-type sausages containing 2.5% of potassium lactate 60%, potassium lactate/sodium diacetate 56%/4% and potassium lactate/potassium diacetate 56%/4%, all in combination with 2% curing salt or SALT Minerals sub4salt® cure.

Attributes were ranked on a scale of 1 to 5, where 1 represented the lowest taste impression or acceptance and 5 the highest, always in comparison to a standard containing curing salt only. Afterwards, the results were statistically analysed using the Friedmann test.

The first attribute the panellists considered was the perceived acidic taste. As shown in graph 6, there was no obvious difference between control and the other formulations. Graph 6 does, however, show a difference in the bitterness impression of formulations containing potassium lactate (PL) and potassium lactate/potassium diacetate (PL/PD) compared to control, with the sensory panel apparently detecting a slightly higher bitterness in the potassium-enriched products. However, statistical analysis of these data revealed no significant difference between the single formulations with regard to bitter aftertaste. In parallel, the highest saltiness was again detected in products containing PL and PL/PD with statistical significance. The formulation containing PL/PD together with sub4salt® cure revealed a slightly lower, yet statistically significant, saltiness impression than control.

Overall, the preferred formulations in terms of taste (taste acceptance) were those that provided increased saltiness. Thus slight bitterness can be offset by the right level of saltiness, as is the case in the formulations containing PL/PD. In this respect, it can be noted that a combination of the PL/PD blend with SALT Minerals sub4salt® cure brings back the bitterness and, at the same time, the saltiness, to the level of the control, but with a substantially lower sodium content.

Graph 6: Results of the sensory evaluation



Conclusion

SALT Minerals potassium lactate and potassium lactate/diacetate blends have been proven to provide excellent antimicrobial function at dosage levels of 2.5% of the 60% commercial solutions. At such concentrations they provide efficient growth inhibition of *Listeria monocytogenes* and aerobic mesophilic bacteria for at least 56 days in cooked sausages stored at 7°C. It can be assumed that increasing the temperature hurdle by applying the generally recommended storage temperature of max. 4°C for meat products would result in an even much longer shelf life under the described conditions. The tests have also shown that 30-40% lower use levels of lactate/diacetate blends still result in a stable end product for the entire test period. This leads to lower cost without compromising on performance. Sensory evaluation has shown a positive impact of SALT Minerals potassium lactate and potassium lactate/diacetate blends on the saltiness of the end product without significant impact on bitterness, resulting in excellent taste acceptance.

Finally, and importantly, these ingredients are a smart way to reduce the sodium content of processed meat products. Sodium can be reduced by over 25% simply by switching from sodium- to potassium-based lactates or lactate blends. And sodium can be reduced by over 50%, with good taste acceptance, when combining the below mentioned lactates with SALT Minerals sub4salt® cure.

SALT Minerals offers a full range of potassium based lactates and blends:

- Potassium lactate 60%
- Potassium lactate/sodium diacetate 56%/4%
- Potassium lactate/potassium diacetate 56%/4%
- Potassium lactate/potassium acetate 56%/4%

Customised blends with different components, ratios and total concentrations can be made on request.

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SALT Minerals GmbH is a leading provider of innovative mineral-based products and solutions, dedicated to addressing global challenges related to health and sustainability. With a diverse product portfolio, SALT Minerals serves industries ranging from food and beverage to industrial applications. Our mission is to deliver sustainable, high-quality salt solutions that enhance everyday life and industrial processes worldwide. With a vision rooted in innovation and a commitment to quality, Salt Minerals continues to elevate the role of mineral salts in shaping a healthier world.

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