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POSSIBILITY OF SALT REDUCTION IN DRY MEAT

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Review paper

Abstract: Excessive sodium intake is widely recognized as a major risk factor for essential hypertension and is associated with a range of adverse health outcomes. According to the World Health Organization, non-communicable diseases represent one of the leading causes of premature mortality worldwide. In response, a global target has been established to reduce population sodium intake by up to 30% by 2025. Meat products constitute a significant source of dietary sodium, particularly fermented sausages and dry-cured meat products. In these products, in addition to low processing and storage temperatures, sodium chloride plays a crucial role as a primary hurdle inhibiting microbial growth and preventing spoilage. Consequently, sodium reduction in such products presents a considerable technological and safety challenge. This is primarily due to the absence of thermal processing, which may increase the risk of microbial proliferation and compromise product safety. This paper examines the potential strategies for sodium reduction in dry-cured meat products, with particular emphasis on microbiological safety, as well as the associated chemical and sensory changes.

Key words: salt reduction, dry meat, sodium

Introduction

Salt (sodium chloride) is one of the earliest and most commonly used food preservatives, particularly for meat (Desmond, 2006). It had significant practical importance, as it enabled longer shelf life for food, especially in winter. Salt intake increased to about 5 g per day and continued to rise until the 19th century when achieved 18 g per day (Roberts and Roberts, 2001).

Excessive sodium intake is recognized as a leading cause of essential hypertension (Hunter et al., 2022). Research indicates that high salt intake leads to increased body mass and elevated total sodium levels in the blood, along with expanded extracellular and plasma volume. At the same time, levels of renin, angiotensin, and norepinephrine are reduced (Haddy, 2006).

Moreover, excessive sodium consumption has been linked to a higher risk of heart attack (Perry and Beevers, 1992), left ventricular hypertrophy (Schmieder and Messerli, 2000), sodium retention in extracellular fluids, and, consequently, the occurrence of clinical and idiopathic edema, particularly in women (MacGregor and de Wardener, 1997). It also contributes to decreased vascular elasticity (Avolio et al., 1986), proteinuria (Du Cailar et al., 2002), greater susceptibility to *Helicobacter pylori* infection and the development of gastric cancer (Tsugane et al., 2004), increased calcium excretion and kidney stone formation (Cappuccio et al., 2000), reduced bone density and osteoporosis (Devine et al., 1995), and more severe asthma attacks (Mickleborough et al., 2005).

According to the World Health Organization (WHO, Fact sheed Nº393), non-communicable diseases, including cardiovascular diseases and stroke, are among the leading causes of premature death worldwide. As a result, a global target was set to reduce sodium intake by 30% by the year 2025. Salt reduction has been identified as one of the most cost-effective public health measures, with estimates suggesting that approximately 2.5 million deaths could be prevented annually (Selmer et al., 2000; Murray et al., 2003; Asaria et al., 2007; Joffres et al., 2007; He and MacGregor, 2009).

In the mentioned document, voluntary global targets are listed:

(1) A 25% relative reduction in the overall mortality from cardiovascular diseases, cancer, diabetes, or chronic respiratory diseases

(2) At least 10% relative reduction in the harmful use of alcohol, as appropriate, within the national context

(3) A 10% relative reduction in prevalence of insufficient physical activity

(4) A 30% relative reduction in mean population intake of salt/sodium

(5) A 30% relative reduction in prevalence of current tobacco use in persons aged 15+ years

(6) A 25% relative reduction in the prevalence of raised blood pressure or contain the prevalence of raised blood pressure, according to national circumstances

(7) Halt the rise in diabetes and obesity

(8) At least 50% of eligible people receive drug therapy and counselling (including glycemic control) to prevent heart attacks and strokes (9) an 80% availability of the affordable basic technologies and essential medicines, including generics, required to treat major noncommunicable diseases in both public and private facilities.

In Table 1, the situation in different regions that have adopted a strategy for reducing salt in food is presented.

Table 1. National sodium/salt reduction initiatives by WHO region (Reducing Salt Intake: What's Happening Around the World, 2024)

Africa	1/47 (2%) South Africa with 2 countries (Ethiopia and Nigeria) in the planning phase
Americas	18/49 (37%) countries / territories with a further 6 countries in the planning stage and 24 without an initiative
Eastern Mediterranean	13/22 (59%) countries
Europe & UK	40/53 (75%) countries / territories
South-East Asia	5/11 countries / territories
Western Pacific	19/37 (51%) countries / territories/areas

Salt reduction in meat products

The most common substitute for sodium chloride is potassium chloride (KCl), but when more than 50% substitution is used, saltiness is significantly reduced and bitterness becomes more pronounced (Armenteros et al., 2012; Barat et al., 2012; Barat et al., 2013). The use of potassium salts is often debated due to potential health risks for sensitive groups, such as individuals with type I diabetes, chronic kidney disease, or heart conditions (FSAI, 2005). Findings of many authors suggest that replacement of sodium chloride with potassium chloride is possible up to 50% without significantly affected color, texture, aroma, or taste.

Over the past decade, studies carried out under projects supported by the Ministry of Education, Science and Technological Development (2010–2019) in the field of technological development have produced numerous scientific outputs related to the reduction of salt content in meat products, and these investigations have continued in recent years. These studies included an analysis of the declared salt content on labels of meat products (Gerić et al., 2021) as well as an evaluation of potential strategies for reducing salt in foods (Xiang et al., 2025). Salt reduction in various groups of meat products was achieved both by decreasing the amount of added salt and by partial substitution of sodium chloride with potassium chloride and ammonium chloride. Particular attention was dedicated to meat products that are not treated by high temperature, such as dried meat products (Lilić et al., 2014; 2015; 2016).

However, salt reduction in dry meat is particular challenge, due to these products are made without any thermal treatment. This is the most important for whole dry hams, where salt penetration occurs slowly, and the inner regions, particularly near the femur and femoral artery, and it presents high microbial risks (Munoz-Rosique et al., 2022; Hernandez Correas et al., 2024).

Relation between salt reduction and microbial status in dry meat

Aliño et al. (2009) investigated the partial substitution of sodium chloride with potassium chloride at a level of 70%, assessing chemical and microbial parameters in dry pork after curing and drying. They found that the salt mixture had no significant impact on the counts of aerobic mesophilic bacteria, halotolerant bacteria, or lactic acid bacteria. The predominant microbiota were halotolerant and lactic acid bacteria.

Sodium chloride does not exhibit a direct antimicrobial effect; its inhibitory action on bacterial growth is primarily due to the reduction of water activity (Devlieghere et al., 2009; Taormina, 2010). According to Prändl (1988), the minimum salt concentrations that inhibit microbial growth are as follows: 5% for *Clostridium botulinum* type E and *Pseudomonas fluorescens*, 6% for *Shigella* and *Klebsiella* strains, 8% for *E. coli*, *Salmonella* spp., *Bacillus cereus*, *Clostridium botulinum* type A, and *Clostridium perfringens*, 10% for *Clostridium botulinum* type B and *Vibrio parahaemolyticus*, 15% for *Bacillus subtilis* and members of the *Streptococcaceae* family, 18% for *Staphylococcus aureus*, 25% for *Penicillium* and *Aspergillus* species, 26% for *Halobacterium halobium*, *Bacterium prodigiosum*, and species of *Spirillum*.

Yamanaka et al. (2005) found that sodium chloride selectively promotes the growth of halotolerant and lactic acid bacteria while suppressing coliform bacteria. The use of salt mixtures containing both sodium and potassium chloride had no significant effect on enterobacteria or coliform bacteria.

Before curing, only Gram-negative bacteria were present in the meat (e.g., *Vibrio*, *Acinetobacter*, *Pseudomonas*, and members of *Enterobacteriaceae*), but during the curing process, the number of Gram-positive bacteria (e.g., *Micrococcus*, *Staphylococcus*, *Pediococcus*) increased, while number of Gram-negative bacteria declined. *Staphylococcus* species are particularly tolerant to high concentrations of sodium chloride (more than 10%), more so than *Micrococcus* species, making their presence expected at the end of the curing period (Yamanaka et al., 2005).

Lorenzo et al. (2015) observed that the number of microorganisms in dry pork changes throughout production. The highest total viable count was recorded in samples cured with a 50:50 mix of sodium chloride and potassium chloride. These findings align with those of Raccach and Henninen (1997), who noted that calcium chloride more effectively inhibits the growth of aerobic mesophilic bacteria compared to a sodium–potassium chloride mixture. However, other studies (Aliño et al., 2010; Blesa et al., 2008) found no significant differences in total viable counts.

Dry meat products made with equal parts sodium and potassium chloride, as well as those with 25% potassium chloride, 20% calcium chloride, and 10% magnesium chloride, contained significantly higher counts of halotolerant bacteria compared to those made with other salt mixtures (Lorenzo et al., 2015). These results contradict findings by Aliño et al. (2010), who reported lower halotolerant bacteria counts when sodium chloride content dropped below 50%. On the other hand, Yamanaka et al. (2005) emphasized that sodium chloride selectively enhances the growth of halotolerant and lactic acid bacteria while suppressing coliforms.

The lowest yeast counts were recorded in dry meat products made exclusively with sodium chloride, indicating that yeasts are sensitive to high sodium concentrations (Lorenzo et al., 2015). However, yeast populations increased significantly toward the end of the curing process, contributing to desirable sensory characteristics due to their lipolytic and proteolytic activity (Purriños et al., 2012, 2015).

Some researchers focused specifically on dry-cured ham and emphasized the importance of maintaining low temperatures (around 3°C) during the post-salting period to prevent microbial growth, especially *Clostridium botulinum* (Ventanas and Cava, 2001). The area at greatest risk for microbial spoilage is the innermost part of the ham, near the femoral artery, due to the lower salt content, higher moisture, and elevated water activity (León-Crespo et al., 1997; Barat et al., 2005). Nevertheless, the substitution of sodium chloride with alternative salts did not result in significant changes in microbial counts (Blesa et al., 2008).

Chemical and sensory changes during salt reduction

Gimeno et al. (1998) investigated the effects of a salt mixture containing sodium chloride (10 g/kg), potassium chloride (5.52 g/kg), magnesium chloride (2.35 g/kg), and calcium chloride (4.4 g/kg), and observed a decrease in pH value. Similar results were obtained with another mixture composed of sodium chloride (10 g/kg), potassium chloride (5.5 g/kg), and calcium chloride (7.4 g/kg) (Gimeno et al., 2001). In contrast, Lorenzo et al. (2015) reported no significant changes in pH value in dry meat products produced with various chloride salt mixtures.

Moisture content was significantly higher in dry meat products made with potassium chloride (Lorenzo et al., 2015; Wu et al., 2014). However, Armenteros et al. (2012) found no significant differences in moisture content between products made with sodium chloride only and those using different chloride salts.

Some studies (Rico et al., 1991; Toldrá et al., 1993) have shown that sodium chloride inhibits the activity of cathepsins B and B+L. Replacing 50–70% of sodium chloride with potassium chloride significantly enhances the activity of these enzymes compared to products treated only with sodium chloride. Cathepsin

H activity does not vary significantly during salting, regardless of the type of chloride salt used. The partial replacement of sodium chloride with 50% potassium chloride increases the activity of cathepsins B and B+L, thereby extending proteolysis. Conversely, dipeptidyl peptidase I activity is higher in meat salted only with sodium chloride, while the activity of dipeptidyl peptidases II and IV remains unchanged. Dipeptidyl peptidase III activity, however, decreases significantly as the share of potassium chloride increases.

Methionyl aminopeptidase activity is inhibited at higher levels of potassium chloride (Armenteros et al., 2009). The activity of aminopeptidases in general is influenced by the type of chloride salts used during meat curing. Specifically, methionyl aminopeptidase is more strongly inhibited with increased potassium chloride content, while alanyl aminopeptidase activity shows no consistent trend when comparing mixtures with and without sodium chloride.

Armenteros et al. (2009) also reported that the most notable changes were observed in sarcoplasmic proteins when sodium chloride was replaced with other chloride salts, while no significant differences were found in myofibrillar proteins. Electrophoretic profiles of myofibrillar proteins revealed intensive degradation of the bonds between myosin and actin during dry-cured meat aging (Toldrá et al., 1993). In contrast, sarcoplasmic protein profiles exhibited greater band density in meat treated with chloride salt mixtures compared to those treated with sodium chloride alone.

The use of alternative chloride salts does not significantly affect lipolytic processes in dry-cured meat. The total content of saturated, monounsaturated, and polyunsaturated fatty acids remains largely unchanged (Armenteros et al., 2009), which is consistent with earlier findings (Countron-Gambotti and Gandemer, 1999) where 50% of sodium chloride was replaced with potassium chloride.

While some findings show consistency, others diverge. For example, Aliño et al. (2009) and Armenteros et al. (2009) demonstrated that up to 50% of sodium chloride could be replaced with a mixture of potassium chloride, magnesium chloride, and calcium chloride in dry-cured pork without significantly affecting the sensory properties of the final product. Similarly, Aliño et al. (2010) found that up to 40% replacement was acceptable in dry-cured ham while maintaining comparable physicochemical characteristics.

The presence of potassium chloride in curing mixtures accelerates the curing process by facilitating faster chloride ion diffusion into deeper muscle layers. As a result, target chloride concentrations are reached more quickly, shortening the overall curing time (Aliño et al., 2010). This is consistent with findings from previous studies (Aliño et al., 2009; Blesa et al., 2008), which confirmed that potassium ions diffuse more rapidly into muscle tissue compared to sodium ions. In contrast, the addition of calcium chloride and magnesium chloride slows the curing process due to the higher electronegativity of their cations, which form stronger bonds with polar groups of proteins, thereby impeding diffusion (Xiong and Brekke, 1991).

Armenteros et al. (2012) found no significant differences in moisture content between dry-cured products made with alternative salt mixtures and traditional products. Conversely, Wu et al. (2014) observed that products made with potassium chloride had significantly higher moisture content than those produced with sodium chloride alone.

Conclusion

Dry-cured meat products are highly valued foods known since ancient times. In most countries, traditional household production has been preserved, as well as modern industrial processing under controlled conditions of drying and fermentation. Since these products are not produced under thermal treatment, their production is classified as high-risk, particularly regarding microbiological spoilage. Therefore, the use of larger amounts of salt is necessary, making the reduction of added salt problematic. The most commonly used replacer for sodium chloride is potassium chloride, whose application is limited by its bitter and metallic taste, allowing only partial replacement of table salt. In most cases, replacement of sodium chloride with potassium chloride is possible up to about 40%. In line with the recommendations of the World Health Organization, these products have also become part of the global initiative to reduce salt in food, which, alongside other meat products, represents a lasting challenge for food science.

Mogućnost smanjenja sadržaja soli u suvom mesu

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Rezime

Kuhinjska so (natrijum hlorid) je najstariji i najčešći dodatak hrani, posebno mesu. Unos soli u današnje vreme daleko prevazilazi nutritivne potrebe, a prekomeran unos natrijuma označen je kao vodeći uzrok esencijalne hipertenzije i povezan je sa nekoliko zdravstvenih poremećaja. Zato je postavljen cilj na sastanku u Ženevi da se unos natrijuma smanji za 30% do 2025. godine, shodno preporukama Svetske zdravstvene organizacije. Proizvodi od mesa su najčešće osuđeni kao najveći izvor soli, odnosno natrijuma, iako je ostala hrana, naročito ona procesuirana značajan izvor natrijuma. U ovom radu su prikazane mogućnosti smanjivanja sadržaja soli u suvom mesu, što predstavlja veliki izazov za industriju mesa iz više razloga. Iako je antimikrobni efekat soli zasnovan na činjenici da se snižava aktivnost vode, u ovim proizvodima, i da nema direktan bakteriostatski ili baktericidni efekat, osim niskih temperatura to je jedina prepreka kvaru, naročito u prvim fazama proizvodnje kao što su soljenje i salamurenje. Najveći izazov je proizvodnja suvih šunki, odnosno celih butova svinja zbog velike mase, gde je penetracija soli veoma dug proces, kao i postojanje predilekcionih mesta za mikrobiološki kvar kao što su dublje partije mesa blizu kostiju i dela mesa blizu femoralnog kanala i femoralne arterije. Najčešće korišćena mogućnost smanjivanja sadržaja soli u suvom mesu je parcijalna supstitucija natrijum hlorida drugim solim, najčešće hloridnim solima, u prvom redu kalijum hloridom, što je limitirano njegovim negativnim uticajem na senzorske osobine suvog mesa, u prvom redu pojavom gorkog i metalnog ukusa. Najčešće je ova supstitucija moguća do 50%, bez izrazitih i statistički značajnih razlika u senzorskim karakteristikama. U radu su prikazane mikrobiološke, hemijske i senzorske promene u suvom mesu sa smanjenim sadržajem soli tokom proizvodnje. Pored negativnih uticaja, navedenim postupkom se značajno poboljšava odnos natrijuma i kalijuma, shodno preporukama Svetke zdravstvene organizacije.

Ključne reči: redukcija soli, suvo meso, natrijum

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Conflict of interest
The authors declare that they have no conflict of interest.

References

Aliño M., Grau R., Toldrá F., Blesa E., Pagán M.J., Barat J.M. 2009. Influence of sodium replacement on physicochemical properties of dry-cured loin. *Meat Science*, 83, 423-430.
Aliño M., Grau R., Fuentes A., Barat J.M. 2010. Characterisation of pile salting with sodium replaced mixtures of salts in dry-cured loin manufacture. *Journal of Food Engineering*, 97, 434-439.
Armenteros M., Aristoy M., Barat J., Toldrá F. 2009. Biochemical changes in dry-cured loins salted with partial replacements of NaCl by KCl. *Food Chemistry*, 117, 627-633.

Armenteros M., Aristoy M.C., Barat J.M., Toldrá F. 2012. Biochemical and sensory changes in dry-cured ham salted with partial replacements of NaCl by other chloride salts. *Meat Science*, 90, 361-367.

Asaria P., Chisholm D., Mathers C., Ezzati M., Beaglehole R., 2007. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. *The Lancet*, 370, 2044–2053.

Avolio A.P., Clyde K.M., Beard T.C., Cooke H.M., Ho K.K., O'Rourke M.F. 1986. Improved arterial distensibility in normotensive subjects on a low salt diet. *Arteriosclerosis*, 6, 166-169.

Barat J.M., Grau R., Ibáńez J.B., Fito P. 2005. Post-salting studies in Spanish cured ham manufacturing time reduction by using brine thawing–salting. *Meat Science*, 69, 201–208.

Barat J.M., Pérez-Esteve E., Aristoy M.C., Toldrá F. 2013. Partial replacement of sodium in meat and fish products by using magnesium salts. *Plant and Soil*, 368, 179-188.

Blesa E., Aliño M., Barat J.M., Grau R., Toldrá F., Pagán M.J. 2008. Microbiology and physico-chemical changes of dry-cured ham during the post-salting stage as affected by partial replacement of NaCl by other salts. *Meat Science*, 78, 135-142.

Cappuccio F.P., Kalaitzidis R., Duneclift S., Eastwood J.B. 2000. Unravelling the links between calcium excretion, salt intake, hypertension, kidney stones and bone metabolism. *Journal of Nephrology*, 13, 169–177.

Countron-Gambotti C., Gandemer G. 1999. Lipolysis and oxidation in subcutaneous adipose tissue during dry-cured ham processing. *Food Chemistry*, 64, 95–101.

Desmond E. 2006. Raducing salt: A challenge for the meat industry. *Meat Science*, 74, 188-196.

Devine A., Criddle R.A., Dick I.M., Kerr D.A., Prince R.L. 1995. A longitudinal study of the effect of sodium and calcium intakes on regional bone density in postmenopausal women. *American Journal of Clinical Nutrition*, 62, 740-745.

Du Cailar G., Ribstein J., Mimran A. 2002. Dietary sodium and target organ damage in essential hypertension. *American Journal of Hypertension*, 15, 222-229.

FSAI. 2005. Salt and health: review of the scientific evidence and recommendations for public policy in Ireland. Food Safety Authority of Ireland, Dublin.

Gerić T., Lilić S., Babić Milijašević J., Vranić D., Jovanović J., Baltic T., Borović B. 2021. Dietary salt/sodium intake through consumption of animal origin foodstuffs available on the Serbian market. *Meat Technology*, 62(1), 33–40.

Gimeno O., Astiasarán I., Bello J. 1998. A mixture of potassium, magnesium and calcium chlorides as a partial replacement of sodium chloride in dry fermented sausages. *Journal of Agricultural and Food Chemistry*, 46, 4372–4375.

Gimeno O., Astiasarán I., Bello J. 2001. Influence of partial replacement of NaCl with KCl and $CaCl_2$ on microbiological evolution of dry fermented sausages. *Food Microbiology*, 18, 329–334.

Haddy F.J. 2006. Role of dietary salt in hypertension. *Life Sciences*, 79, 1585-1592.

He F.J., MacGregor G.A. 2009. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. *Journal of Human Hypertension*, 23(6), 363-384.

Hernández Correas N., Abellán A., Cayuela J. M., Bande-De León C., Tejada L. 2024. Effect of overripening on the physico-chemical and sensory characteristics of boneless, salt-reduced Iberian dry-cured ham. *Foods*, 13*(*10), 1588.

Hunter W.R., Dhaun N, Bailey A.M. 2022. The impact of excessive salt intake on human health. Nature Reviews Nephrology, 18, 321-335.

Joffres M., Campbell N., Manns B., Tu K. 2007. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. *Canadian Journal of Cardiology*, 23, 437–443.

León-Crespo F., Galán-Soldevilla H., Peralta-Fernández A., Ciudad-González N., Balderas-Zubeldia B., Céspedes-Sánchez F., Martín-Serrano A., Torres-Muńoz M.C. 1997. La salazón del jamón: bases para una tecnología racional. *Cárnica, 2000*, July, 33–51.

Lilić S., Borović B., Vranić D. 2014. Mogućnosti supstitucije natrijum-hlorida nekim hloridnim solima u procesu proizvodnje suvog svinjskog mesa. *Tehnologija mesa*, 55, 2, 176-183.

Lilić S., Vranić D. 2015. Promene aktivnosti vode i sadržaja natrijuma, kalijuma, magnezijuma i kalcijuma u svinjskom mesu salamurenom različitim hloridnim solima. *Tehnologija mesa*, 56(2), 137-143.

Lilić S., Babić J., Borović B., Spalević Lj., Maslić-Strižak D., Pavlović M., Milijašević M. 2016. Effect of sodium chloride reduction in dry pork on sensory quality parameters and instrumentally measured colour. *Biotechnology in Animal Husbandry*, 32(4), 383-391.

Lorenzo J.M., Bermúdez R., Domínguez R., Guiotto A., Franco D., Purriños L. 2015. Physicochemical and microbial changes during the manufacturing process of dry cured lacon salted with potassium, calcium and magnesium chloride as sa partial replacement for sodium chloride. *Food Control*, 50, 763–769.

MacGregor G.A., De Wardener H.E. 1997. Idiophatic edema. In: Schrier R. W., Gottschalk C.W., eds. *Diseases of the Kidney*. Little Brown and Company, Boston.

Mickleborough T.D., Lindley M.R., Ray S. 2005. Dietary salt, airway inflammation and diffusion capacity in exercise-induced asthma. *Medicine and Science in Sports and Exercise*, 37(6), 904-914.

Muñoz-Rosique B., Hernández-Correas N., Abellán A., Bueno E., Gómez R., Tejada L. 2023. Influence of pig genetic line and salt reduction on peptide production and bioactivity of dry-cured hams. *Foods*, 12(5), 1022.

Murray C.J.L., Lauer J.A., Hutubessy R.C.W., Niessen L., Tomijima N., Rodgers A., Lawes C.M.M., Evans D.B. 2003. Effectiveness and costs of interventions to lower systolic blood pressure and cholesterol. *The Lancet*, 361, 717–725.

Perry I.J., Beevers D.G. 1992. Salt intake and stroke: a possible direct effect. *Journal of Human Hypertension*, 6, 23-25.

Prändl O. 1988. Verarbeitung des Fleisches, Grundlagen der Haltbarmachung, Fleisch: Technologie und Hygiene der Gewinnung und Verarbeitung, Stuttgart: Ulmer, 234–372.

Purriños L., Franco D., Carballo J., Lorenzo J. M. 2012. Influence of the salting time on volatile compounds during the manufacture of dry-cured pork shoulder "lacón". *Meat Science*, 92, 627-634.

Purriños L. 2015. Physicochemical and microbial changes during the manufacturing process of dry-cured lacón salted with potassium, calcium and magnesium chloride as a partial replacement for sodium chloride. *Food Control*, 50, 763-769.

Reducing Salt Intake: What's Happening Around the World. 2024. Available at: https://khni.kerry.com/articles/nutrition-regulations-policies/reducing-salt-intake-whats-happening-around-the-world/. Accessed 2 April 2026.

Rico E., Toldrá F., Flores J. 1991. Effect of dry-cured process parameters on pork muscle cathepsin B, H, and L activities. Zeitschrift fur Lebensmittel-Untersuchung und-Forschung, 193, 541–544.

Roberts W.C., Roberts W.C. 2001. Facts and ideas from anywhere. *Proceedings Baylor University Medical Center*, 14(3), 314-322.

Schmieder R.E., Messerli F.H. 2000. Hypertension and the heart. *Journal of Human Hypertension*, 14, 597–604.

Selmer R.M., Kristiansen I.S., Haglerød A., Graff-Iversen S., Larsen H.K., Meyer H.E., Bonaa K.H., Thelle D.S. 2000. Cost and health consequences of reducing the population intake of salt. *Journal of Epidemiology & Community Health*, 54, 697–702.

Toldrá F., Rico E., Flores J. 1993. Cathepsin B, D, H and L activities in the processing of dry-cured ham. *Journal of the Science of Food and Agriculture*, 62, 157–161.

Tsugane S., Sasazuki S., Kobayashi M., Sasaki S. 2004. Salt and salted food intake and subsequent risk of gastric cancer among middle-aged Japanese men and women. *British Journal of Cancer*, 90, 128–134.

Ventanas J., Cava R. 2001. Dinámica y control del proceso de secado del jamón ibérico en secaderos y bodegas naturales y en cámaras climatizadas. In: *Tecnología del jamón ibérico. De los sistemas tradicionales a la explotación racional del sabor y el aroma* (255-293). Mundi-Prensa, Madrid.

WHO. 2014. Fact sheed N°393, Salt reduction. Available at: http://www.who.int/mediacentre/factsheets/fs393/en/. Accessed 2 April 2026.

Wu H., Zhang Y., Long M., Tang J., Yu X., Wang J. et al. 2014. Proteolysis and sensory properties of dry-cured bacon as affected by the partial substitution of sodium chloride with potassium chloride. *Meat Science*, 96, 1325-1331.

Xiang Y., Lin X., Zheng M., Deng K., Miao S., Zheng B., Zhang L. 2025. Salt reduction in processed meat products: Integrated strategies and mechanisms to maintain saltiness perception. *Trends in Food Science & Technology*, 166, 105420.

Xiong Y.L., Brekke C.J. 1991. Gelation properties of chicken myofibrils treated with calcium and magneisum chlorides. *Journal of Muscle Foods*, 21-36.

Yamanaka H., Akimoto M., Sameshima T., Arihara K., Itoh M. 2005. Effects of bacterial strains on the development of the ripening flavor of cured pork loins. *Animal Science Journal*, 76, 499-506.

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