# THE EFFECT OF STARTER CULTURES ON THE LENGTH AND PERIMETER LOSS IN DRY-CURED PORK LOIN

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**Abstract:** The research aims to determine how starter cultures affect the loss in length and perimeter in dry-cured pork loin produced in combination with nitrite salt and alternative natural sources of nitrites (Swiss chard powder). The research was conducted under industrial conditions. Five groups of dry-cured pork loin were produced in three iterations, namely: I group: table salt, dextrose; II group: nitrite salt, dextrose; III group: nitrite salt, dextrose and starter culture BactoFerm Rosa; IV group: table salt, dextrose, Swiss chard powder (manufacturer 1) and starter culture BactoFerm Rosa and V group: table salt, dextrose, Swiss chard powder (manufacturer 2) and starter culture BactoFerm Rosa. The length and perimeter were measured at the beginning (pork loin - raw material) and at the end of the production process (dry-cured pork loin-finished product). The length loss in all five groups of dry-cured pork loin ranges from 29.29 to 29.95%. There was a statistically significant difference ($p \leq 0.05$) in length loss between the groups where starter culture was added (III, IV and V) compared to the groups where no starter culture was added (I and II). The greatest loss of perimeter during the production process of dry-cured pork loin is observed in group III (24.56%), while the smallest loss in perimeter is found in group I (24.04%). The added starter culture had a statistically significant ($p \leq 0.05$) effect on greater perimeter loss. The added starter culture results in a greater loss in length and perimeter, which contributes to the reduction of the production process.
**Keywords:** dry-cured pork loin, starter culture, length loss, perimeter loss, profitable

## 1. INTRODUCTION

Drying is probbly the oldest of all food preservation techniques. Preserving food in this way allowed our distant ancestors to survive in times of food scarcity. As it is pointed out, Babić and Babić (2000), the process of drying food started as early as 20000 B.C. Primitive people dried meat in order to prevent it from spoiling and increase its shelf life (Savić, 2004). As Krvavica et al. (2016) point out, the first written information about the preservation of pork by drying dates to the early Roman period, in the territory of what was then Norcia in central Italy. The practice of preserving pork through salting and drying, which originated in Ancient Rome, eventually made its way to the European continent. In 1493, Christopher Columbus introduced this method of pork preservation to the American continent (Krvavica et al., 2016).

Presently, dry cured meat products are highly esteemed and regarded as the epitome of superior quality meat products. The production process of dry cured meat products varies across different regions, characterized by intricate and prolonged procedures, thereby validating their elevated price.

Dry cured meat products are derived from different types of meat, including bone-in pieces with subcutaneous fat and skin. These products may or may not incorporate salt and spices. Preservation is achieved through salting or curing and drying methods, sometimes involving smoking, or without smoking altogether, resulting in a state that is safe for consumption without prior heat treatment.

The production of dry cured meat products consists of the following technological operations: selection and processing of raw materials, salting/curing, cold smoking and ripening. Following common table salt, the meat processing industry frequently employs potassium nitrite (E 249), sodium nitrite (E 250), sodium nitrate (E 251), and potassium nitrate (E 252) as prevalent preservatives (Silovska Nikolova and Belichovska, 2020). Nitrites and nitrates are traditionally used in meat products because of their antimicrobial effect on *Clostridium botulinum* and other bacteria (Majou and Christieans, 2018; Flores and Toldrá, 2021). Nitrites are used for red color development, prevention of fat oxidation and flavor development (Shakil et al., 2022).

The utilization of nitrites can have adverse health effects on consumers due to the formation of nitrosamines. As a result, consumers are inclined towards meat products with fewer additives. Numerous authors have extensively researched and explored the use of natural alternative sources of nitrates and nitrites derived from vegetable extracts. Promising outcomes have been achieved in their quest to find acceptable alternatives (Eisinaite et al., 2016; Riel et al., 2017; Choi et al., 2017; Kim et al., 2017; Jin et al., 2018; Kim et al., 2019; Altunay and Elik 2020).

A number of authors affirm that incorporating starter cultures in the meat industry yields advantageous effects on sensory properties, safety, shelf-life extension, and production uniformity (Incze, 2002; Leroy et al., 2006; Maksimović et al., 2015; Laranjo et al., 2017; Rivera et al., 2019; Laranjo et al., 2019)

The aim of this research is to determine how the use of starter cultures in combination with nitrite salt and alternative sources of nitrites will affect the loss in perimeter and length in dry-cured pork loin.

## 2. MATERIALS AND METHODS

### Materials

The experiment was carried out in the meat industry "Rimes MS Group". To evaluate the effectiveness of Swiss chard powder as a natural nitrite source and the influence of starter cultures on weight loss during the production of dry-cured pork loin, five groups of dry-cured pork loin were produced as outlined below:

- **I group:** table salt, dextrose;
- **II group:** nitrite salt, dextrose;
- **III group:** nitrite salt, dextrose and starter culture BactoFerm Rosa;
- **IV group:** table salt, dextrose, Swiss chard powder (manufacturer 1) and starter culture BactoFerm Rosa;
- **V group:** table salt, dextrose, Swiss chard powder (manufacturer 2) and starter culture BactoFerm Rosa.

In the research, a frozen external part of the pork loin was used (*m. longissimus dorsi*). Figure 2 shows the technological steps of the production of dry-cured pork loin in sequence.

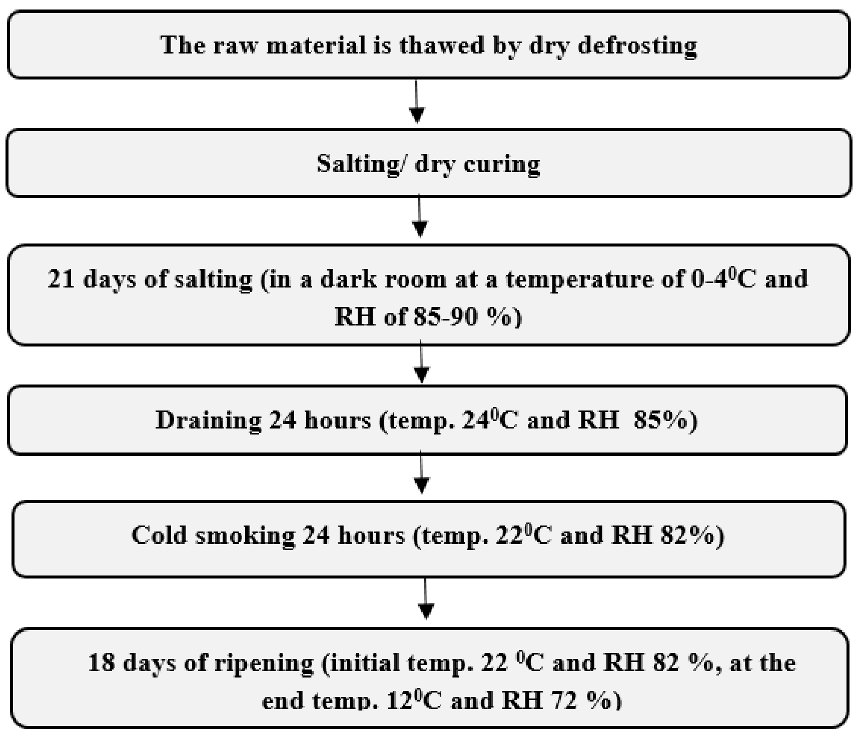



**Figure 1. Presentation of the technological process of the production of dry-cured pork loin**

### Methods

The perimeter loss during the production of the dry-cured pork loin is the difference between the perimeter of the pork loin before salting and the perimeter of the dry-cured pork loin after ripening, which is expressed as a percentage in relation to the perimeter before salting the pork loin.

The perimeter of the pork loin is measured in the middle part of the piece of pork loin dry-cured pork loin as in Figure 3.

The length loss during the production of the dry-cured pork loin is the difference between the length of the pork loin before salting and the length of the dry-cured pork loin after ripening, which is expressed as a percentage in relation to the length of the pork loin before salting.

The length of the pork loin is measured from one end to the other end of the piece of pork loin/dry-cured pork loin as in Figure 3.

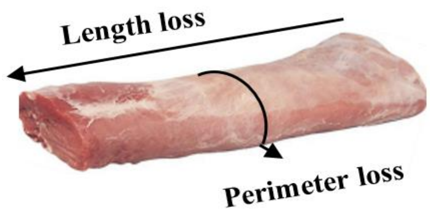



**Figure 2. Schematic representation of measurement of length and perimeter loss in dry-pork loin**

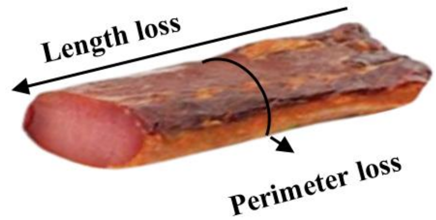



**Figure 3. Schematic representation of measurement of length and perimeter loss in dry-cured pork loin**

The data collected in the experiment were processed and edited using the program Excel xp. The normality of the distribution of the values was checked by analyzing the homogeneity of the variances. If the homogeneity was confirmed, the analysis was continued with the multivariate general linear model (GLM) or the ANOVA test (comparison of three or more groups), and the associations between the parameters with the multivariate linear descriptive analysis (LDA) (IBM SPSS Statistics 23, release 23.0.0.0).

## 3. RESULTS AND DISCUSSION

### Length loss in dry-cured pork loin

Table 1 shows the initial and final length of the dry-cured pork loin expressed in centimeters, while Graph 1 shows the length loss in dry-cured pork loin during the production process expressed in %.

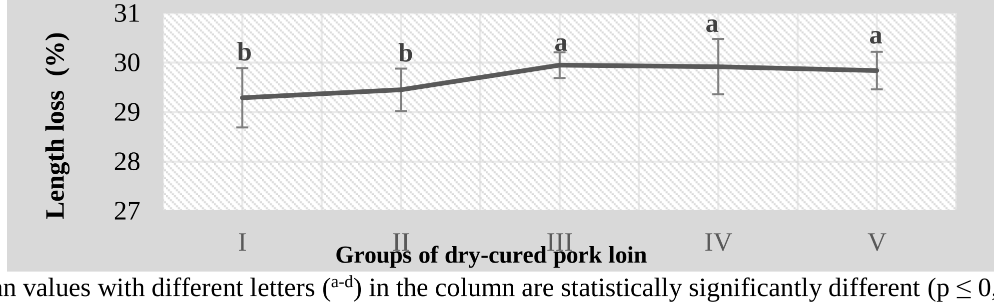
**Table 1. Length loss in dry-cured pork loin during the production process expressed in centimeters**

| Production stage | Groups of dry-cured pork loin | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| | $\bar{x} \pm SD$ | | | | |
| **Beginnning of production process** | 55.58 ± 0.47$^{a}$ | 55.51 ± 0.52$^{a}$ | 55.64 ± 0.55$^{a}$ | 55.77 ± 0.48$^{a}$ | 55.45 ± 0.59$^{a}$ |
| **End of production process** | 39.30 ± 0.52$^{a}$ | 39.16 ± 0.40$^{ba}$ | 38.96 ± 0.44$^{b}$ | 39.08 ± 0.53$^{ba}$ | 38.90 ± 0.36$^{b}$ |

**$\bar{x}$ - sample mean; SD-standard deviation; Different letters ($^{a-d}$) of the indexes of the values in the rows indicate a statistically significant difference ($p \leq 0.05$); Different letters ($^{A-C}$) of the indexes of the values in the columns indicate a statistically significant difference ($p \leq 0.05$).**

The length of the pieces of pork loin (the raw material) before the beginning of the production process ranges from 55.45 (V group) to 55.64 cm (III group).No statistically significant difference was observed between the pieces, i.e. there are no large deviations in the length of the used raw material. At the end of the production process, the length of the dry-cured pork loin (finished product) ranges from 38.90 (V group) to 39.30 (I group). When it comes the pieces of dry-cured pork loin after the end of the production process, although the difference in length is small, it is still statistically significant ($p \leq 0.05$).

**Graph 1. Length loss in dry-cured pork loin during the production process**




Mean values with different letters ($^{a-d}$) in the column are statistically significantly different ($p \leq 0,05$)

The values obtained from the length loss in dry-cured pork loin during the production process also show us the dynamics of the ripening of the dry-cured pork loin. Length and perimeter reduction in dry cured meat products during ripening is related to water loss (dehydration and evaporation). According to Ruiz-Ramirez et al., (2005), the decrease in water content leads to a reduction in the mass, the perimeter of the product itself.

The greatest length loss in dry-cured pork loin was observed in group III (29.95%), while the smallest length loss was observed in group I (29.29 %).

Groups III, IV, and V, which incorporated the starter culture, exhibited a more significant decrease in length compared to groups I and II, where no starter culture was included.

The added starter culture has a statistically significant effect ($p \leq 0.05$) on length loss in dry-cured pork loin.

**Perimeter loss in dry-cured pork loin**

Table 2 shows the perimeter loss in dry-cured pork loin at the beginning and at the end of the production process expressed in centimeters, while Graph 2 shows the length loss in dry-cured pork loin during the production process expressed in %.

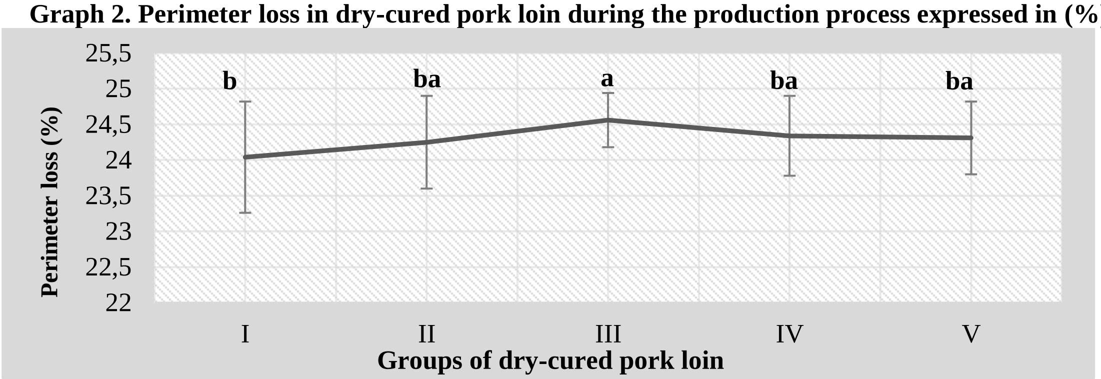
**Table 2. Perimeter loss in dry-cured prok loin during the production process expressed in cm**

| Production stage | Groups of dry-cured pork loin | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| | $\bar{x} \pm SD$ | | | | |
| **Beginning of production process** | $25.43 \pm 0.63^a$ | $25.68 \pm 0.65^a$ | $25.60 \pm 0.36^a$ | $25.49 \pm 0,50^a$ | $25.55 \pm 0,55^a$ |
| **End of production process** | $19.32 \pm 0.45^a$ | $19.45 \pm 0.46^a$ | $19.32 \pm 0.31^a$ | $19.28 \pm 0,37^a$ | $19.34 \pm 0,46^a$ |

**$\bar{x}$ - sample mean; SD-standard deviation; Different letters ($^{a-d}$) of the indexes of the values in the rows indicate a statistically significant difference ($p \leq 0.05$); Different letters ($^{A-C}$) of the indexes of the values in the columns indicate a statistically significant difference ($p \leq 0.05$)**

At the beginning of the production process, the perimeter ranged from 25.43 (I group) and 25.68 cm (II group). There is no statistically significant difference between the pieces. The pieces are relatively equal in length. At the end of the production process, the perimeter of the dry-cured pork loin ranged from 19.28 (IV group) to 19.45 (II group).

**Graph 2. Perimeter loss in dry-cured pork loin during the production process expressed in (%)**




Mean values with different letters ($^{a-d}$) in the column are statistically significantly different ($p \leq 0,05$)

During the production process of dry-cured pork loin, apart from the water separation, the weight loss also contributes to a decrease in the perimeter of the product. The size of the dry-cured pork loin pieces can vary depending on the speed and intensity of ripening. This physical quantity can serve as an indicator of the ripening kinetics of the dry-cured pork loin.

The greatest perimeter loss during the production process of dry-cured pork loin is observed in group III (24.56%), while the smallest perimeter loss is found in group I (24.04%). The influence of the starter cultures on perimeter reduction of dry-cured pork loin is statistically significant ($p \leq 0.05$).

According to professional literature, the incorporation of starter cultures in dry cured meat products aids in reducing their ripening time (Laranjo et al., 2017).

## 4. CONCLUSION

Based on the obtained results, it can be concluded that the use of starter cultures has a notable effect on achieving a greater reduction in both length and perimeter within the same ripening time frame. This indicates a shortened ripening period. Every manufacturer aims to enhance production profitability.

## REFERENCES

Altunay, N., & Elik, A. (2020). A green and efficient vortex-assisted liquid-phase microextraction based on supramolecular solvent for UV–VIS determination of nitrite in processed meat and chicken products. *Food Chemistry*, *332*,127395.

Babić, Lj., & Babić, M. (2000). *Sušenje i skladištenje*. Poljoprivredni fakultet, Novi Sad.

Choi, Y.S., Kim, T.K., Jeon, K.H., Park, J.D., Kim, H.W., Hwang, K.E., & Kim, Y.B. (2017). Effects of pre-converted nitrite from red beet and ascorbic acid on quality characteristics in meat emulsions. *Korean Journal of Food Science of Animal Resources, 37*(2), 288-296.

Eisinaite, V., Vinauskiene, R., Viskelis, P., & Leskauskaite, D. (2016). Effects of Freeze-Dried Vegetable Products on the Technological Process and the Quality of Dry Fermented Sausages. *Journal of Food Sciences, 81*(9), 2175-2182.

Flores, M., & Toldrá F. (2021). Chemistry, safety, and regulatory considerations in the use of nitrite and nitrate from natural origin in meat products - Invited review. *Meat Science*, *171*, 108272.

Incze, K. (2002). Fermented meat products - A review of current research topics. *Fleischwirtschaft, 8*2 (4), 112-118.

Jin, S.K., Choi, J.S., Yang, H.S., Park, T.S., & Yim, D.G. (2018). Natural curing agents as nitrite alternatives and their effects on the physicochemical, microbiological properties and sensory evaluation of sausages during storage. *Meat Science, 146*, 34-40.

Kim, T. K., Kim, Y. B., Jeon, K. H., Park, J. D., Sung, J. M., Choi, H. W., Choi, Y. S. (2017). Effect of fermented spinach as sources of pre-converted nitrite on color development of cured pork loin. *Korean Journal for Food Science of Animal Resources, 37* (1), 105–113.

Kim, T.K., Hwang, K.E., Lee, M.A., Paik, H.D., Kim, Y.B., Choi, Y.S. (2019). Quality characteristics of pork loin cured with green nitrite source and some organic acids. *Meat Science, 152*, 41-145.

Krvavica, M., Jelić, M., Velić, A., Lučin, M., & Gajdoš Kljusurić, J. (2016). Fizikalna svojstva i oksidativni status dalmatinske pečenice proizvedene u različitim tehnološkim uvjetima. *Meso, 5* (12), 414-421.

Laranjo M, Potes M.E, & Elias M. (2019). Role of Starter Cultures on the Safety of Fermented Meat Products. *Front Microbiol, 26* (10), 853.

Laranjo, M., Elias, M., & Fraqueza, M. J. (2017). The Use of Starter Cultures in Traditional Meat Products. *Journal of Food Quality*, 1-18.

Leroy, F., Verluyten, J., & Vuyst, L. (2006). Functional meat starter cultures for improved sausage fermentation. *International Journal of Food Microbiology, 106* (3), 270-285.

Majou, D., & Christieans, S. (2018). Mechanisms of the bactericidal effects of nitrate and nitrite in cured meats. *Meat Science, 145*, 273–284.

Maksimović, T., Hulak, N., Vuko, M., Kovačević, V., Kos, I. & Mrkonjić M. (2015). Lactic acid bacteria in traditional dry sausage production. *Meso,17* (6), 575-580.

Riel, G., Boulaaba, A., Popp, J., & Klein, G. (2017). Effects of parsley extract powder as an alternative for the direct addition of sodium nitrite in the production of mortadella-type sausages -Impact on microbiological, physicochemical and sensory aspects. *Meat Science, 131*, 166-175.

Rivera, N., Bunning, M., & Martin, J. (2019). Uncured-labeled meat products produced using plant-derived nitrates and nitrites: Chemistry, safety, and regulatory considerations. *Journal of Agricultural and Food Chemistry, 67* (29), 8074-8084.

Ruiz-Ramirez, J., Serra, X., & Arnau, J., Gou, P. (2005). Profi les of water content, water activity and texture in crusted dry - cured loin and in non crusted dry - cured loin. *Meat Science, 69* (3), 519-525.

Savić, Z., & Savić, I. (2004). *Sausage Casings*. Victus, Vienna.

Shakil, M.H, Trisha, A.T, Rahman, M., Talukdar, S., Kobun, R., Huda, N., & Zzaman, W. (2022) Nitrites in Cured Meats, Health Risk Issues, Alternatives to Nitrites: A Review. *Foods, 11*(21), 3355.

Silovska Nikolova, A., & Belichovska, D. (2020). Application of nitrites and nitrates as preservatives in processed meat production. *Knowledge - International Journal, 38* (3), 525–530.