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Original scientific paper

THE EFFECT OF STARTER CULTURES ON WEIGHT LOSS IN DRY-CURED PORK LOIN PRODUCED WITH AND WITHOUT NITRITES

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ABSTRACT

Since ancient times, man has used caves and natural shelters as an ideal places for drying meat. Dry cured meat products are products of high nutritional value and a long shelf life. Therefore, they occupy a special place on the consumers' tables. This research aims to determine how added starter cultures affect on weight loss during the production process in dry-cured pork loin produced with and without nitrites. Five groups of dry-cured pork loin were produced in three iterations. I (the first) negative control group (table salt, dextrose), II positive control group (nitrite salt, dextrose); Group III (nitrite salt, dextrose and starter culture), group IV (table salt, Swiss chard powder from the first manufacturer, dextrose and starter cultures) and group V (table salt, Swiss chard powder from the second manufacturer, dextrose and starter cultures). The weight loss during salting ranged from 2.37 (II group) to 2.50 (III group). After smoking, the weight loss ranged from 10.84% (II group) to 11.27% (V group). During ripening, the weight loss ranged from 30.99 (I group) to 31.61 % (III group). The weight loss during the entire production process was the highest in group III (40.83%), while it was the lowest in group I (40.10%). The difference in weight loss observed between groups was statistically significant ($p \leq 0.05$). Added starter culture in dry-cured pork loin contributes to a higher weight loss during the production process, which contributes to shortening the production process and more profitable production.

Key words: starter cultures, Swiss chard powder, curing, salting, smoking, and ripening.

INTRODUCTION

According to the Regulations on the requirements regarding the quality of minced meat, meat preparations and meat products (Official Gazette of the Republic of Macedonia No. 63 from 2013), dry-cured pork loin is a product obtained from the outer part of the pork loin from which the bones , and the connective /adipose tissue were previously removed. It is preserved by salting or curing, cold smoking, drying and ripening.

Drying is one of the oldest methods of preserving meat. As stated by Zukál and Incze, 2010 food drying was originally based on the use of energy from the sun and wind. Drying is a physical method of preserving meat. The production of durable dry-cured meat products usually combines salting and cold smoking.

Krvavica et al., (2016) state that the drying process primarily results in loss of water (dehydration and evaporation), which is manifested with the loss of product weight. By reducing the amount of water in the product, the activity of microorganisms also decreases, thereby extending the product's shelf life.

The mixture used for dry salting usually contains nitrite salt. The use of nitrites limits and prevents the growth and development of microorganisms.

From a technological point of view, they are important for the color stability in meat products. Also, they prevent the oxidation of fats and improve the taste of the product (Silovska Nikolova and Belichovska, 2022). The use of nitrites is legally regulated. The maximum allowed concentration is determined, depending on the type of meat product, which eliminates the possibility of their excessive use (Silovska Nikolova and Belichovska, 2021a).

Nitrites negatively affect human health due to the interaction with secondary amines and the formation of N-nitrosamines which are carcinogenic (Flores and Toldrá, 2021).

Bernardo et al., (2021) state that synthetic nitrite can be replaced by a plant source of nitrate in the production of meat products, but the use of starter cultures is necessary so that nitrate-reducing bacteria can reduce nitrate to nitrite.

Starter cultures can be used in an acidic environment, an environment with high salt concentrations, they are active at low temperatures, they can develop in anaerobic conditions, and nitrites do not inhibit their metabolism. They contribute to the production of a safe product with inherent sensory properties, constant and standard quality of meat products, and also contribute to more profitable production (Silovska Nikolova and Belichovska, 2021b).

The purpose of this paper is to determine the weight loss after salting, after smoking, after ripening and during the entire production process of dry-cured pork loin produced in industrial conditions with and without use of nitrite and starter culture. It also focuses on how starter culture and natural source of nitrites (Swiss chard powder) will affect on weight loss during the production process in dry-cured pork loin.

MATERIALS AND METHODS

Materials

Dry dry-cured pork loin, produced in industrial conditions is used in the analysis. The origin of the raw material - frozen pork loin is from Spain (Costa Food Meat, Sl.). As an alternative to nitrite salt in the production of dry-cured pork loin, the following is used: Swiss chard powder (from PI-1, Bulgaria (first manufacturer) and Naturex, France (second manufacturer) in combination with the starter culture BactoFerm Rosa, produced by Chr. Hansen, Denmark. Table salt is produced by Solana (Bosnia and Herzegovina). Dextrose is produced by ADM Amylum, Bulgaria) and nitrite salt is obtained from Alkaloid, N. Macedonia.

The experiment was carried out in the meat industry in N. Macedonian. Their usual technological way of producing dry-cured pork loin is taken as a basis. Five groups of dry-cured pork loins were produced in three iterations as follows:

- I group negative control: with added table salt and dextrose;
- II group positive control: with added nitrite curing salt and dextrose;
- III group: with added nitrite curing salt, dextrose and starter culture BactoFlavor Rosa (*Staphylococcus vitulinus* и *Staphylococcus xylosus*);
- IV group: with added Swiss chard powder (from the first manufacturer), dextrose and starter culture BactoFlavor Rosa (*Staphylococcus vitulinus* и *Staphylococcus xylosus*);
- V group: with added Swiss chard powder (from the second manufacturer), dextrose, and starter culture BactoFlavor Rosa (*Staphylococcus vitulinus* и *Staphylococcus xylosus*);

In the research, a frozen external part of the pork loin (*m. longissimus dorsi*) was used, from which the bones, and the connective /adipose tissue were previously removed. The technological process of production the dry-cured pork loin was carried out in the following way:

The raw material is thawed by dry defrosting

↓

Removal of adipose tissue and fascia. Shaping the pieces

↓

Salting/ dry curing

↓

21 days of salting in a dark room
(at a temperature of 0-4^{0}C and relative humidity of 85-90 %)

↓

Draining 24 hours
(temperature 24^{0}C and relative humidity of 85%)

↓

Cold smoking 24 hours
(temperature 22^{0}C and relative humidity of 82%)

↓

18 days of ripening
(initial temperature 22 ^{0}C and relative humidity of 82 %, at the end temprature 12^{0}C and relative humidity of 72 %

Methods

The weight loss during the production process is calculated gravimetrically. During the production process, weight loss was calculated during: salting, smoking, ripening and the total weight loss.

Weight loss during salting is the difference between the weight of the pork loin before salting and its weight after salting, which is expressed as a percentage in relation to the weight of the pork loin before salting.

Weight loss during smoking is the difference between the weight of the pork loin before smoking and its weight after smoking, which is expressed as a percentage in relation to the weight of the pork loin before smoking.

Weight loss during ripening is the difference between the weight of the pork loin before ripening and its weight after ripening, which is expressed as a percentage in relation to the weight of the pork loin before ripening.

Total weight loss is the difference between the weight of the pork loin before salting and the weight of the pork loin after ripening, which is expressed as a percentage of the weight of the pork loin before salting.

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).

The experiment evaluating weight loss was set up as a 5 × 10 × 3 factorial experiment (5 experimental groups, 10 samplings (on different days during processing and storage), and 3 production iterations. If the interaction between group and sampling was statistically significant ($p < 0.05$), it was included in the statistical model, and vice versa, it was excluded.

RESULTS AND DISCUSSION

The weight loss at the end of each production process (after salting, after smoking and after ripening) is shown in graph 1 to graph 3, while the weight loss during the entire production process is shown in graph 4.

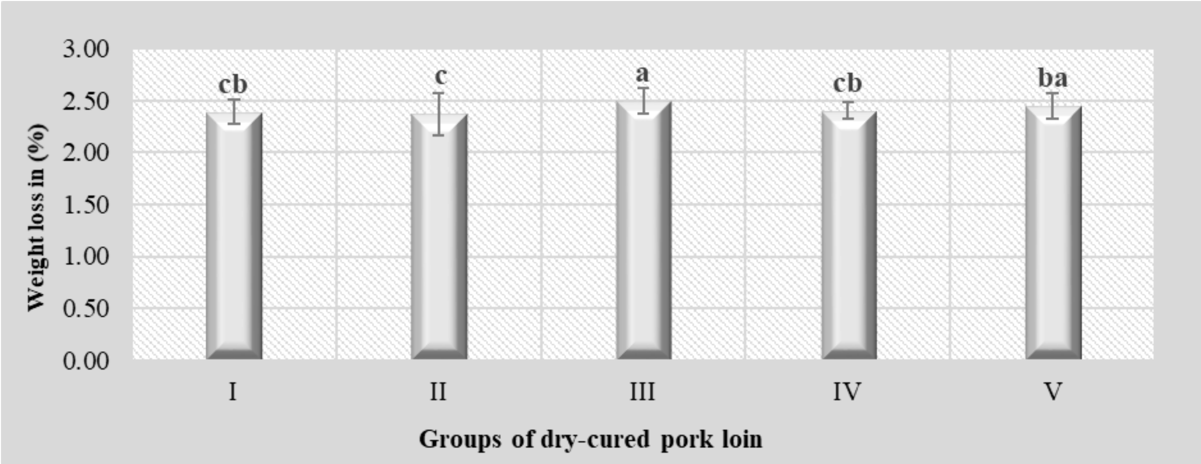
The smallest weight loss during the entire production process is observed after salting. It ranges from 2.37 (II group) to 2.50 % (III group) (Graph 1). The obtained results are in accordance with the data from the professional literature. During the production of Dalmatian dry-cured pork loin in different technological conditions, Krvavica et al., (2016) noted a weight loss of 2.49 to 2.90% after salting.

Differences in weight loss between groups during salting are statistically significant ($p \leq 0.05$). This difference is due to technical reasons.

Krvavica et al., (2016) point out that the type of salting/curing mixture and the salting time do not affect weight loss during salting in Dalmatian dry-cured pork loin. Also, Andronikov et al. (2013) state that the time and percentage of salt/cure utilization per kg of meat does not significantly affect weight loss during salting.

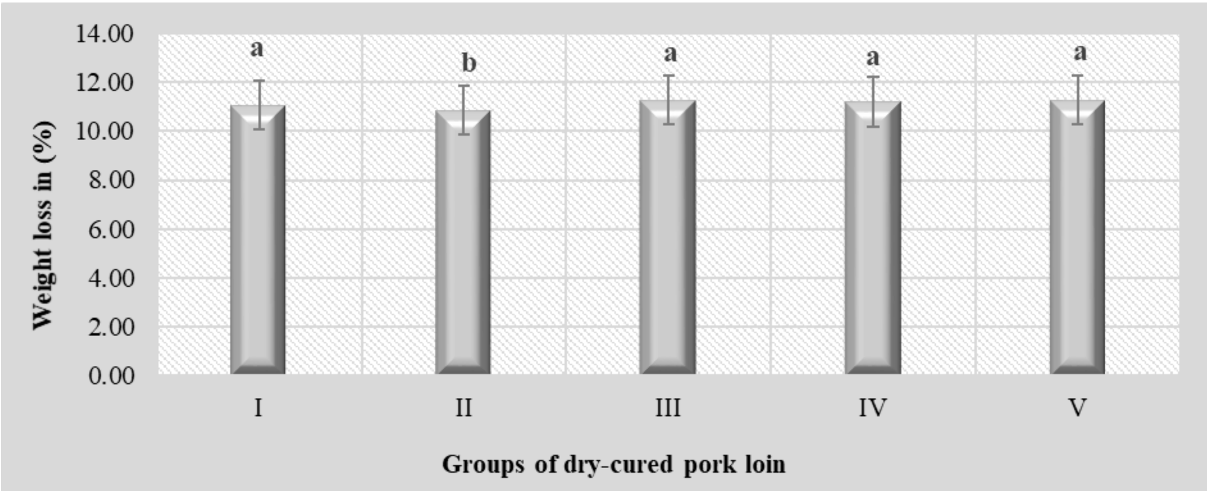
Weight loss during salting is due to fluid loss resulting from the hygroscopic characteristics of sodium chloride (Jin et al., 2010; Ferreira et al., 2022).

After finishing the smoking process, the smallest loss in weight was observed in group II (10.84%), while the highest loss in weight was observed in group V (11.27%) (Graph 2). The differences ($p \leq 0.05$) between the II group and the other groups of dry-cured pork loin are statistically significant. This difference may arise from a technical aspect.



the mean values with a different letter ([a-d]) in the column are statistically significantly different ($p \leq 0.05$)

Graph 1. Weight loss after salting

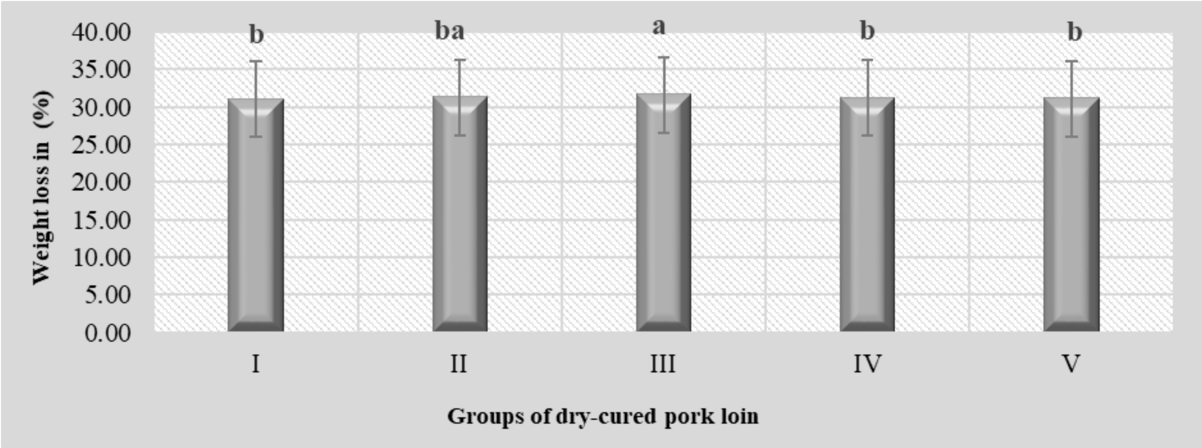


the mean values with a different letter ([a-d]) in the column are statistically significantly different ($p \leq 0.05$)

Graph 2. Weight loss after smoking

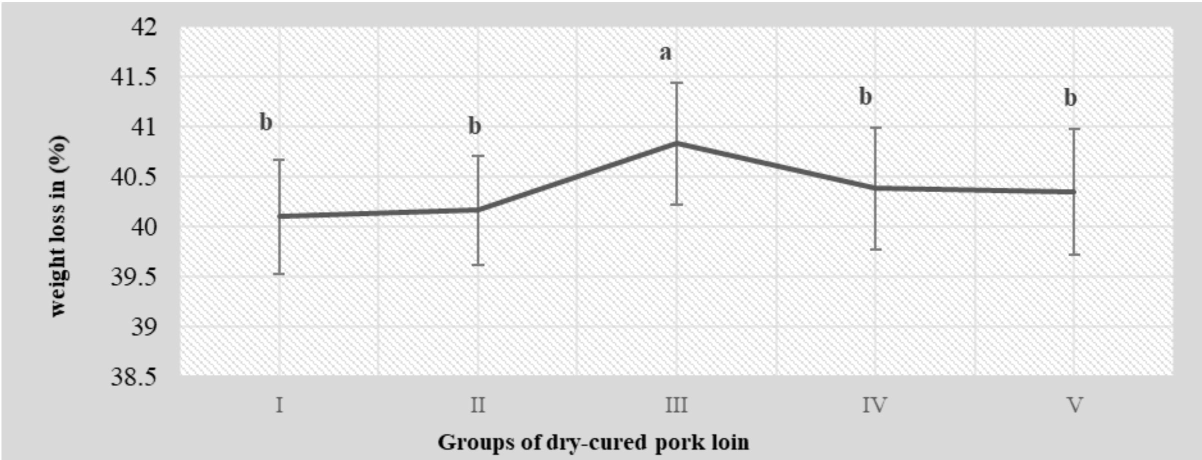
After the end of ripening, as can be seen from graph 3, the weight loss ranges from 30.99 (I group) to 31.61 % (III group). The difference in weight loss after smoking observed between the groups is statistically significant ($p \leq 0.05$).

During the ripening stage, weight loss occurs due to evaporation of the liquid from the piece of meat into the surrounding air (Jin et al., 2010; Ferreira et al., 2022), due to which the weight of the piece decreases. Weight loss during ripening is a very significant indicator of the intensity and speed of ripening. If ripening takes place at a higher temperature, low relative humidity, rapid air circulation and a longer period of ripening, the loss in weight is higher (Leistner, 1986; Muguerza et al., 2002; Ikonić, 2012).



the mean values with a different letter ([a-d]) in the column are statistically significantly different ($p \leq 0{,}05$)

Graph 3. Weight loss after ripening



the mean values with a different letter ([a-d]) in the column are statistically significantly different ($p \leq 0{,}05$)

Graph 4. Total weight loss of dry-cured pork loin during the production process

Weight loss during the production of dry meat products for the entire production process depends on numerous internal factors (the processing method, weight, surface area, quality of the raw material, pH of the meat, the proportion of adipose tissue and meat, etc.) and external factors (the method of salting/curing, the microclimatic conditions, the processing method, the length of separate processing stages, etc.) (Krvavica and Đugum, 2007; Jin et al., 2010; Andronikov et al., 2013; Krvavica et al., 2016).

The lowest total loss in weight during the production process is observed in group I (40.10%), followed by group III (40.83%), where the biggest loss in weight during the production process was observed. During the production of Dalmatian dry-cured pork loin in different technological conditions, Krvavica et al., (2016) found that weight loss during the production process ranges from 26.91-49.53% (an average of 39.99%). The obtained results for total loss in weight during the production process in dry-cured pork loin are in accordance with research conducted by Andrés et al., 2004; Aliño et al., 2010; Seong et al. 2015.

Krvavica et al., 2016 state that the use of frozen raw material contributes to higher weight loss during the production process. Also, they point out that the initial weight of the raw material has a great influence on weight loss. In our research, the longer production process is due to the use of frozen raw material and the removal of fat and fascia. All this contributed to a higher loss in weight in a shorter period of time. That would contribute to shortening the production process.

Graph 4 indicates that the loss in weight during the production process is higher in the groups of dry-cured pork loin in which starter cultures were added. III (40, 83%), IV (40,38%) and V (40, 34 %) compared to the groups of dry-cured pork loin in which no starter cultures were added: II positive control group (40.16%) and I negative control group (40.10%). The results obtained from this research are in accordance with a large number of information from other authors, which state that the addition of starter cultures in meat products contributes to a greater loss of weight during the production process, compared to samples containing natural microflora (Incze, 1992, Feiner, 2006).

As could be seen from graph 4, the difference that occurs between group III and the other four groups of dry-cured pork loin is statistically significant ($p \leq 0.05$), which is probably a consequence of the differences in the initial weight of the tested samples and the addition of starter culture.

CONCLUSION

Based on the obtained results of this research, it can be concluded that the use of starter culture contributes to a higher loss in weight in dry-cured pork loin. It also contributes to the shortening of the production process for dry-cured pork loin. This could potentially enhance the profitability of production, a goal pursued by every producer.

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