Journal of Animal and Veterinary Advances 8 (10): 2094-2099, 2009
ISSN: 1680-5593

Effects of Starter Culture Use on Some Quality Parameters of Pastrami Manufactured from Water Buffalo Meat

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Abstract: The present research was carried out to investigate, the effects of commercial starter culture (*Staphylococcus carnosus* and *Staphylococcus carnosus* + *Lactobacillus pentosus*) use on some chemical, microbiological and sensorial characteristics of pastrami traditionally manufactured from water buffalo meat. Significant differences were observed throughout the storage period between groups treated with or without commercial starter cultures with respect to both sensory qualities and the pH value. The highest sensorial values were observed on 60th and 15th day of storage period for the groups with added starter cultures. Pronounced increase was demonstrated in the sensory quality of the groups with added starter cultures that is the most significant criterion for the manufacture and marketing of pastrami. Furthermore, the use of commercial starter cultures was determined to contribute to the microbiological characteristics of pastrami. Thus, using starter cultures in pastrami manufacture could ensure good quality and safety end product.

Key words: Meat products, starter culture, product quality, pastrami, storage period

INTRODUCTION

Pastrami, first produced by the Central Asian Turks, is consumed following the salting (dry curing), drying and paste-seasoning (cemening) on the surface of muscle and is served either raw or cooked after being thinly sliced. Dating back to the settlement of Turkish people in Anatolia, the manufacture of pastrami has become a traditional art in Kayseri (Tekinsen and Dogruer, 2000; Gonulalan and Kose, 2003). Charque in South America, Kilishi in Nigeria and West Africa, Qwanta in Ethiopia and East Africa, Odka in Somalia and biltong in South Africa are traditional products similar to pastrami that are also, prepared from cut meat.

In accordance with Turkish Standards Institute, pastrami is defined as a meat product prepared by means of the technical processing, drying and a cemening of meat cuts obtained from the carcasses of cattle or water buffaloes (Anonymous, 1983). High quality products that can be stored for a long period are reported to be manufactured from processed meat obtained from fully developed buffaloes slaughtered under adequate hygiene and sanitation procedures at modern slaughterhouses (Yashoda *et al*., 2000). Meat obtained from water buffalo carcasses are considered to be high quality due to adequate muscular development and low rate of fat (Solomon *et al*., 1985). Generally, meat obtained from cows at age of 3-6 years, bullocks (castrated male cattle at the age of 1.5-4 years) and castrated male buffaloes that are in good fattening condition are used for pastrami manufacture (Tekinsen and Dogruer, 2000). The total water buffalo population and total water buffalo meat production of Turkey in the year 2004 have been reported as 104,000 and approximately, 4,146,000 kg, respectively (Anonymous, 2007). Water buffalo meat is of great importance as a source of animal protein for some countries including Italy, Egypt, Bulgaria, Australia and Venezuela. In certain regions, water buffalo meat is consumed in much greater amounts than beef. In India, while beef is not consumed due to the sacredness of cattle according to religious belief, beef has been substituted with water buffalo meat (Bender, 1992). In Italy (Paleari *et al*., 2000), the product named Bresaola, normally manufactured from beef by means of salting (in marinade) is also manufactured from water buffalo meat. Therefore, a new market has been indicated to be established for various cured products manufactured from water buffalo meat.

The typical starter cultures of cured products manufactured from cut meat consist of LAB and

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species belonging to the *Micrococcoceae* family, which contribute to the development of sensory quality and ensure microbial safety (Lucke, 1986). S*taphylococcus carnosus* and *Staphylococcus xylosus* have been reported to catabolize many amino acids and at the same time have been demonstrated to constitute almost all of the significant volatile taste components of cured meat in which, they were used as a starter culture due to their ability to efficiently reduce nitrate (Montel *et al*., 1996; Stahnke, 1999; Talon *et al*., 1999). On the other hand, while lactic acid bacteria contribute to the development of quality parameters including aroma and texture due to the generation of amino acids by their proteolytic enzymes, these bacteria may also be used in the manufacture of fermented meat products, as either probiotic or bioprotective cultures, for their role in the production of lactic acid, antimicrobial peptides, bacteriocins and other compounds with low molecular weight (Pennacchia *et al*., 2004; Silvina *et al*., 1998; Tyopponen *et al*., 2003).

This study was undertaken to determine the effects of the *Staphylococcus carnosus* (Bactoferm™ C-P-77) and *Staphylococcus carnosus* + *Lactobacillus pentosus* (C-P-77S Bactoferm™) commercial starter cultures on certain chemical, microbiological and sensory parameters of pastrami manufactured from water buffalo meat.

MATERIALS AND METHODS

The striploin cuts of water buffalo meat (*M. longissimus* lumborum of 2 years old male water buffaloes belonging to the same herd) provided from a private slaughterhouse were used in this study.

A total of 9 striploin samples were kept at +4°C for 1 day and were subsequently divided into 3 groups. *Staphylococcus carnosus* (Bactoferm™ C-P-77) and *Staphylococcus carnosus* + *Lactobacillus pentosus* (C-P-77S Bactoferm™) commercial starter cultures were applied to the first (a) and second (b) groups, respectively according to the manufacturer's instructions. The third group was manufactured as a control group. Following the starter culture application to meat groups, a 30 min vacuumed tumbling procedure (20 milibars, 3 min of vacuum, 1 min of resting) (Suhner Massager, Tender-Vac VT-300, AGCH 5620) was applied to enable the homogenous distribution of microorganisms (Guner *et al*., 2008). The tumbling procedure was applied separately to each group and tumbling equipment was cleaned and disinfected after each application. The pastrami manufacture was commenced according to traditional methods following homogenous distribution of cultures in meat by the tumbling procedure in the two groups.

Pastrami manufacture stages: All external fat and connective tissues were trimmed. Meat were dry cured (10±2°C for 36 h RH 80±2%). One hundred gram NaCl, 1 g $NaNO_3$, 1.00 g glucose, 1.00 g sucrose were applied for 1 kg meat. After dry curing, meat were desalted with water (15±2°C for 20 min). Desalted meat were dried (18±2°C for 3 days in RH 80±2%), pressed (1.0 kg cm^{-2}, 10±2°C for 12 h in RH 80±2 %), secondly dried (18±2°C for 3 days in RH 75±2%) secondly pressed (1.0 kg cm^{-2}, 18±2°C for 2 h in RH 75±2) and third drying step was applied (18±2°C for 3 days in RH 70±2%). After the third drying step, meat samples in all groups were dipped into cemen paste, which is also, used as an edible coating material in pastrami production process. Cemen paste was prepared using 500 g flour from *Trigonella foenum* graecum seed, 350 g smashed fresh garlic, 75 g red pepper powder, 75 g paprika and 1200 mL water. After cemening for 3 days (10±2°C in RH 80±2%), the surface of the meat was shaved to provide 3-4 mm of cemen paste thickness on the surface and dried for 2 days (18±2°C in RH 60±2%) before analysis (Tekinsen and Dogruer, 2000; Aksu *et al*., 2004). Three replicates were carried out for each group.

Pastrami manufactured from water buffalo meat was sliced and divided into portions of 250 g and stored at refrigerator temperature (4°C) after being vacuum-packed in PVC packages. Manufactured and ripened (16 days) pastirma samples were subjected to chemical, microbiological and sensorial analysis. Samples were analyzed during 60 days of storage period.

Chemical analysis: Moisture, pH, salt, protein, fat and ash analysis of the samples were determined according to the methods of AOAC (1990).

Bacteriological analysis: Coliform bacteria, *Staphylococcus/Micrococcus* sp., *Lactobacillus* sp., yeasts-molds, *Psychrotrophic*, *Halophylic* and total mesophilic aerobic microorganism load of the samples were enumerated (BAM, 1998).

In the sensory evaluation of pastrami samples, criteria including texture, color, aroma and general taste were evaluated by a 9-point hedonic scale; 9 categories ranging from dislike extremely (1) to like extremely (9). In sensorical panel, the questionnaire was completed by 66 target consumers (50% male; 50% female) from the age between 18-30. The consumers were non-vegetarian. The consumers were asked to complete a questionnaire comparing the three samples. The samples were presented in a completely randomized order (AMSA, 1978).

Statistical analyses: The differences related to pH values, moisture contents, *Staphylococcus/Micrococcus*, Lactic

acid bacteria, *Psychrotrophic* microorganism, yeasts and molds, *Halophylic* microorganism, Total mesophilic aerobic microorganism counts and the sensorial analyze results of pastrami were statistically evaluated by one-way ANOVA test (Akgul, 2003).

RESULTS AND DISCUSSION

Results are shown in Table 1. The initial pH, moisture, salt, protein, fat and ash values (%) of meat used in the manufacture of pastrami were determined as 5.62±0.09, 71.02±0.15, 0.54±0.11, 21.04±0.11, 2.25±0.29 and 5.63±0.30, respectively and the initial microorganism content was found to be 2.68±1.05, 3.73±0.40, 3.71±0.12, 3.72±0.24, <1, 3.35±0.10 and 5.56±0.02 (log_{10} cfu g^{-1}), respectively, for *Coliform* bacteria, *Staphylococcus/Micrococcus* sp., *Lactobacillus* sp., yeasts-molds, *Psychrotrophic*, *Halophylic* and total mesophilic aerobic microorganisms. On the 1st day following the pastrami manufacture process, the number of *Coliform* microorganisms were detected to be below the detection limit, while the salt, protein, fat and ash (%) components were 4.61±0.26, 32.15±0.20, 6.21±0.32 and 7.23±0.27, respectively.

The evaluation of the data obtained in this study with regard to pH value demonstrated the pH values measured in the groups throughout the storage period to range between 5.56-5.75 in the control group; 5.69-5.50 in group A and 5.55-5.40 in group B. The difference between the pH values measured in all three groups on the 60th day of the storage period was statistically significant. While, the pH value increased significantly by the end of the 60th day in comparison to the 1st day in the control group, the pH value displayed gradual decrease till the end of the storage period in Groups A and B that were inoculated with *Staphylococcus carnosus* and *Staphylococcus carnosus* + *Lactobacillus pentosus* cultures, respectively. This drop of pH observed in Groups A and B could be attributed to the activity of starter cultures.

Moisture content is regarded as one of the most important factors, which effect the survival of the microorganisms in food matrix. No remarkable change was observed in moisture values of any treatment groups throughout the storage period compared to the 1st day that could be considered as normal for a vacuum-packed meat product.

The difference between the three groups with respect to the number of *Staphylococcus/Micrococcus* sp. by the end of the storage period was determined to be statistically significant. In addition to the significant

Table 1: Effect of starter cultures and storage (+4°C) period on quality of pastrami

Groups	1st day	7th day	15th day	30th day	60th day
	X±SE				
pH					
Control	0.07±5.6^{Cb}	0.06±5.6^{Bb}	0.05±5.6^{Ba}	0.04±5.7^{Aa}	0.02±5.7^{Aa}
Group A	0.08±5.7^{Aa}	0.01±5.6^{Ba}	0.01±5.5^{Cb}	0.01±5.5^{Cb}	0.03±5.5^{Db}
Group B	0.06±5.5^{Ab}	0.08±5.5^{Ac}	0.06±5.5^{Bc}	0.06±5.4^{Cc}	0.04±5.4^{Cc}
Moisture content (%)					
Control	0.17±52.3^{b}	0.23±52.4^{b}	0.12±52.8^{b}	0.15±52.4^{b}	0.09±52.1^{b}
Group A	0.21±53.5^{a}	0.19±53.2^{a}	0.20±53.4^{a}	0.10±53.1^{a}	0.12±52.8^{a}
Group B	0.19±52.5^{b}	0.11±52.4^{b}	0.12±52.4^{b}	0.13±52.2^{b}	0.16±52.2^{b}
***Staphylococcus/Micrococcus* counts (log_{10} cfu g^{-1})**					
Control	0.07±4.7^{Dc}	0.12±4.7^{Cc}	0.11±4.7^{Bc}	0.05±4.7^{Bc}	0.21±5.0^{Ac}
Group A	0.12±6.0^{Da}	0.24±6.0^{Da}	0.16±6.0^{Ca}	0.12±6.6^{Ba}	0.22±6.9^{Aa}
Group B	0.24±5.6^{Eb}	0.09±5.7^{Db}	0.10±5.8^{Cb}	0.14±6.2^{Bb}	0.14±6.7^{Ab}
Lactic acid bacteria counts (log_{10} cfu g^{-1})					
Control	0.21±3.2^{Ac}	0.08±3.3^{Bc}	0.12±3.1^{Cc}	0.09±3.1^{Cc}	0.20±3.0^{Dc}
Group A	0.17±3.9^{Ab}	0.07±3.9^{Ab}	0.14±3.8^{Bb}	0.19±3.8^{Bb}	0.09±3.4^{Cb}
Group B	0.25±5.0^{Da}	0.04±5.3^{Ca}	0.13±5.6^{Ba}	0.18±5.6^{Ba}	0.05±5.7^{Aa}
***Psychrotrophic* microorganism counts (log_{10} cfu g^{-1})**					
Control	0.14±4.8^{Bc}	0.21±4.4^{Dc}	0.14±4.6^{Cc}	0.10±5.0^{Ac}	0.14±4.7^{Bb}
Group A	0.16±5.3^{Bb}	0.14±5.4^{Bb}	0.09±5.4^{Ab}	0.11±5.4^{Ab}	0.08±5.5^{Aa}
Group B	0.20±5.6^{Ca}	0.22±6.0^{Aa}	0.05±5.7^{Ba}	0.17±5.5^{Da}	0.20±5.5^{Da}
Yeasts and molds counts (log_{10} cfu g^{-1})					
Control	0.06±2.1^{Db}	0.14±2.3^{Cb}	0.09±2.4^{Bc}	0.25±2.5^{Ab}	0.12±2.6^{Aa}
Group A	0.22±2.2^{Ca}	0.09±2.5^{Ba}	0.11±2.6^{Aa}	0.06±2.6^{Aa}	0.16±2.5^{Bb}
Group B	0.06±2.1^{Db}	0.19±2.4^{Bb}	0.15±2.6^{Ab}	0.14±2.4^{Bc}	0.10±2.3^{Ca}
***Halophilic* microorganism counts (log_{10} cfu g^{-1})**					
Control	0.15±5.5^{Aa}	0.25±5.4^{Ba}	0..15±5.1^{Cb}	0.17±4.9^{Db}	0.10±4.9^{Ec}
Group A	0.12±5.4^{Cb}	0.19±5.3^{Cb}	0.21±5.9^{Ba}	0.16±6.0^{Aa}	0.23±6.1^{Aa}
Group B	0.26±4.9^{Cc}	0.28±5.0^{Bc}	0.20±4.7^{Cc}	0.17±5.0^{Bb}	0.09±5.3^{Ab}
Total mesophilic aerobic microorganism counts (log_{10} cfu g^{-1})					
Control	0.09±6.2^{Eb}	0.11±6.4^{Dc}	0.12±6.7^{Cc}	0.18±6.8^{Bc}	0.23±6.9^{Ac}
Group A	0.26±7.8^{Ba}	0.05±7.2^{Db}	0.15±7.3^{Cb}	0.22±7.8^{Bb}	0.19±8.0^{Ab}
Group B	0.12±7.7^{Da}	0.12±7.5^{Ea}	0.09±7.9^{Ca}	0.17±8.2^{Ba}	0.25±8.6^{Aa}

Values in rows with same superscript (A-E) and in column with same superscript (a-c) do not differ significantly (p>0.05)

Table 2: Sensorical analyse results of pastrami samples

Groups	1st day	7th day	15th day	30th day	60th day
	----------X±SE----------				
Flavor					
Control	0.03±7.5^{c}	0.15±7.5^{c}	0.17±7.6^{b}	0.22±7.7^{c}	0.19±7.6^{c}
Group A	0.32±8.4^{Ba}	0.24±8.5^{Ba}	0.36±8.5^{Ba}	0.33±8.6^{Aa}	0.20±8.8^{Aa}
Group B	0.30±7.9^{Bb}	0.19±8.0^{Bb}	0.27±.2^{Aa}	0.36±8.3^{Ab}	0.41±8.2^{Ab}
Texture					
Control	0.15±6.9^{Bb}	0.22±6.8^{Bc}	0.34±7.0^{Bc}	0.19±7.1^{Ab}	0.20±7.3^{Ac}
Group A	0.28±7.7^{Da}	0.09±7.6^{Db}	0.16±7.9^{Cb}	0.25±8.3^{Ba}	0.13±8.5^{Aa}
Group B	0.30±7.9^{Ba}	0.36±8.1^{Ba}	0.27±8.1^{Ba}	0.15±8.2^{Aa}	0.24±8.3^{Aa}
Color					
Control	0.06±7.2^{b}	0.11±7.3^{b}	0.21±7.4^{c}	0.14±7.4^{c}	0.22±7.4^{b}
Group A	0.18±7.6^{Ba}	0.12±7.9^{Aa}	0.26±7.9^{Aa}	0.008±8.1^{Aa}	0.30±8.0^{Aa}
Group B	0.19±7.7^{Ba}	0.22±7.7^{Ba}	0.44±7.6^{Bb}	0.36±7.8^{Ab}	0.33±7.8^{Aa}
Overall appearance					
Control	0.09±7.2^{Ac}	0.12±7.2^{Ab}	0.21±7.2^{Ab}	0.14±7.2^{Ac}	0.09±7.0^{Bc}
Group A	0.11±8.0^{Db}	0.10±8.2^{Ca}	0.28±8.6^{Ba}	0.15±8.9^{Aa}	0.10±8.9^{Aa}
Group B	0.16±8.3^{Ba}	0.20±8.4^{Aa}	0.13±8.5^{Aa}	0.21±8.4^{Ab}	0.15±8.1^{Cb}

Values in rows with same superscript (A-E) and in column with same superscript (a-c) do not differ significantly ($p>0.05$)

increases compared to initial values by the end of the storage period within all groups, gradual increase was observed in groups A and B with added starter cultures, starting from the 1st day of the storage period. *Staphylococcus/Micrococcus* sp. numbers reached the maximum level at the end of the storage period in Group A. In this study, *Staphylococcus/Micrococcus* sp. growth was not significantly affected by the presence of *Lactobacillus pentosus* or by acidification. This result does not agree with Lizaso *et al*. (1999) who consider the acidification as the main cause of *Micrococcaceae* inhibition, but in line with Gonzalez and Diez (2002). Observed increases in *Staphylococcus/Micrococcus* sp. numbers in this study are of great importance technologically since it is known that *Micrococcaceae* improves sensory properties because of their intense lipolytic and proteolytic activity.

The numbers of lactic acid bacteria decreased in the control group and group A throughout the storage period, whereas these bacteria increased in group B probably due to *Lactobacillus pentosus* content. The fermentation promotes the growth of lactic acid bacteria. Aksu and Kaya (2001) also indicated that pastrami provides good growth conditions for *Staphylococcus* sp. and lactic acid bacteria.

The data indicated no significant difference in *psychrotrophic* microorganism counts in the control group by the end of the storage period compared to the initial value while, the increase in group A was detected to be statistically significant. On the other hand, significant decrease was observed in Group B compared to the initial value. Low pH values and the competitive flora (lactic acid bacteria) probably contribute to the inhibition of *Psychrotrophic* microorganism as stated by Kotzelidou and Lazarides (1991).

Significant increase was determined in all groups with respect to the numbers of yeasts and molds by the end of the storage period in comparison to the initial values. The counts of yeast and mold reached maximum levels at day 15 and decreased during the storage period in groups A and B, but increase continued in control group until the end of storage period indicating that starter culture use may be effective to contribute to the microbial safety of the product in respect to yeast and mould contents.

Halophylic microorganism counts of groups A and B increased significantly during storage period while, in the control group significant decrease was observed by the end of the 60th day, compared to the 1st day.

When, results are evaluated with regard to the number of mesophilic aerobic microorganisms, significant increases were determined in all three groups compared to initial values by the end of the storage period. The highest mesophilic aerobic microorganism count was observed in group B with added *Staphylococcus carnosus* + *Lactobacillus pentosus*. Similar results were also indicated by Aksu and Kaya (2002) in pastrami samples inoculated with *Staphylococcus xylosus* + *Lactobacillus sakei*.

Furthermore, with respect to the most significant criterion for the manufacture and marketing of pastrami, namely sensory quality, significant gradual decrease was determined in the control group in comparison to the initial value, whereas significant increases were observed in groups A and B. The highest sensorial values were observed on 60th and 15th day of storage period for the groups A and B, respectively (Table 2). Observed difference in sensory analysis, between the groups by the end of the storage period is also, considered to be statistically significant. Apparent increase in sensorial properties was recorded in pastrami produced with *Staphylococcus carnosus*.

CONCLUSION

The present research is enlightening the influence of starter cultures on sensorial and microbiological parameters of pastrami manufactured from water buffalo meat. In this study, significant differences were observed throughout the storage period between groups treated with or without commercial starter cultures with respect to both sensory qualities and the pH value and pronounced increase was demonstrated in the sensory quality of the groups with added starter cultures. Furthermore, the use of commercial starter cultures was determined to contribute to the microbiological characteristics of pastrami. The significant increase observed in the lactic acid bacteria counts by the end of the 60th day in group B with added *Lactobacillus pentosus* also ensures competitive flora (lactic acid bacteria) contributing to microbial safety of pastrami. Thus, using starter cultures in pastrami manufacture could ensure both high and standard quality end product.

ACKNOWLEDGEMENT

This study was supported by Erciyes University, Scientific Research Projects Funds.

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