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Effects of Storage Time on Quality Characteristics of Frozen Turkey Meat

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Abstract: The samples were stored at -18ºC and undergone microbial analysis, chemical characteristics and sensory evaluation at 2-month intervals. Mean bacterial loads and coliform counts were $7.1\times10^7\pm2.0\times10^6$ and $1.9\times10^7\pm7.1\times10^6$ CFU/g. In this study, frozen storage was more effective than either treatment alone at decreasing total and coliform counts. Microbial analysis indicated that freezing storage had a significant effect ($p<0.05$) on the reduction of microbial loads. Frozen storage of samples months had no significant effect on their Total Volatile Nitrogen (TVN) contents during two-month storage, while storage more than 2 months significantly increased the PV and TVN for samples. Storage of packed meat under frozen condition enhanced product shelf life for 2 months without undesirable and detrimental effects on its sensory acceptability.

Key words: Frozen storage, lipid oxidation, microbial analysis, sensory evaluation, turkey meat

INTRODUCTION

Highly perishable foods such as meat provide excellent conditions for the growth of hazardous microorganisms. With the harsh environment and the absence of refrigeration, the shelf life of such meat is expected to be very short. Microbial contamination can lower the quality of fresh minced camel meat; shorten its shelf life and result in economic loss and probably health hazards. Freezing is known to reduce viable cell counts by 1-2 log units, while prolonged storage causes additional, timedependent reductions (Yammamoto and Harris, 2001). In addition, Gill (1996) affirmed that the principal factors to be addressed in the preservation of chilled meat are the retention of an attractive, fresh appearance for the product displayed, and the retardation of bacterial spoilage (Gill, 1996).

Improving shelf life of chicken meat by elimination of some spoilage and pathogenic microorganisms was indicated by several researchers (Javanmard *et al*., 2006; Mulder *et al*., 1977; Thayer *et al*., 1986; Urbain, 1989). Several studies have been conducted on the microbiological quality of red meat, poultry and their products (Anon, 1996; CDC, 1999; Huffman, 2002; IAEA, 1993; WHO, 1986; WHO, 1989) but there is some lack of information on the microbiological quality of turkey meat which may be contaminated with organisms of various kinds including potentially pathogenic bacteria. No data have been published on the changes of turkey meat characteristics during storage time. Our objective was to investigate the quality of turkey carcasses in freezing condition (-18ºC) by the microbiological, chemicaland sensory properties analysis of turkey meat.

MATERIALS AND METHODS

Preparation of sample: Samples of turkey meat weighting 2700±100 g were purchased at a slaughterhouse (Zanjan, Iran) on the day of slaughtering in summer 2010. The samples were randomly divided into 16 equal parts (Each turkey was divided into four groups and each group contained four equal samples weighting 150±30 g). This Study was performed in Department of Food Science- Islamic Azad University, Shahr-e-qods Branch, Iran in September 2010.

Packaging: A Packaging machine model A200, (Henkelman, Netherlands) was used for packing. Meat samples were randomly assigned to packages (sterile polyester polyethylene (PET/Poly) pouches (thickness-62l m)). The packs remained in storage at -18ºC for the entire duration of the experiment. Samples were analyzed at 0, 60, 120, 180 days post-slaughter.

Microbiological evaluation: Total aerobic microbial and coliform count and *Salmonella* spp. analysis was carried out on the day of arrival and months 2, 4 and 6 of storage for each sample using AOAC procedure (AOAC, 1990). 10 g of turkey meat were transferred to a sterilized glass bottle containing 90 mL of sterile physiological water (0.1%). The bottle was shaken to homogenize the sample (AOAC, 1990). For bacterial counts, serial decimal

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dilutions were made using the same media and then volumes of 0.1 mL of selected dilutions were spread, in duplicate, on plates containing solid nutrient agar (Merck) and incubated for 48 h at 30ºC. Microbial counts were expressed as the number of viable bacterial colonies per gram (log CFU/g) (Ayres, 1960). For coliform counts, volumes of 1 mL of selected dilutions were spread, in duplicate onto plates containing approximately 12 mL of melted violet red bile agar (VRBA) and incubated for 48 h at 37˚C. For isolation of *Salmonella* spp. 25 g of turkey meat were incubated at 37ºC in 225 mL of lactose broth for pre-enrichment. Selective enrichment was done in selenite cystine broth at 37ºC and tetrathionate broth at 44˚C followed plating on brilliant green agar and bismuth sulphite agar plates for detection of characteristic colonies of *Salmonella* after incubation for 48 h (Kamat *et al*., 2000). Total molds and yeasts were enumerated on malt agar medium after incubation at 25ºC for 3-5 days (APHA, 1992).

Physical and chemical analysis:

Texture assessment: Tensile strength was calculated from the maximum load during a tension test carried to rupture the specimen (Honikel, 1998) by using an instron Model Testometric (M350-10CT, Rochdale, England). Muscles were cut perpendicular to the muscle fiber orientation to produce 2 cm thick slices. Slices were hooked to the testing machine and the resistance to tearing (tensile stress) was determined at tensile velocity of 60mm/min.

Total volatile nitrogen: Total Volatile Nitrogen (TVN) was determined as described by Mwansyemela (Mwansyemela, 1973).

Peroxide Value (PV): Peroxide value was an index of lipid oxidation. Detection was achieved by monitoring iodine liberated from NaI by lipid peroxides. Briefly, 1g of turkey fat was cut with a bistoury. After the samples were dissolved in acetic acid-chloroform solution, 0.5 mL of saturated potassium iodine (83.2 g solid KI/40 mL H_2O) was added and mixed vigorously. Subsequently, 30 mL deionized water was added and the solution was mixed thoroughly. Color of the upper aqueous layer ranged from pale yellow to bright yellow, with the lower organic layer remaining white. The mixture was allowed to stand for 5-10 min at room temperature then titrated with 0.01 N $Na_2S_2O_3$ (Sigma Chemical, Fair Lawn, NJ) gradually with vigorous shaking. During the titration, 0.5 mL of starch indicator (Starch 1% with chloroform 0.3%, Lab Chem., Inc., Pittsburgh, PA) was added. Color of the upper aqueous layer ranged from light purple to dark purple and the lower organic layer remained white to gray. If the color of the lower organic layer remained yellow, the sample was vigorously swirled and allowed to stand for an additional10 min. The end-point of titration was established when the color of the upper aqueous layer disappeared (Javanmard *et al*., 2006). The PV was calculated employing the following formula:

$$PV = (V)\ (N)\ (1000) / W$$

where, V= consumed volume of $Na_2S_2O_3$ during the titration (mL), N = normality of $Na_2S_2O_3$ and W= sample weight (g).

Measurement of color values: CIE color values were measured on the surface of samples using a LabScan colorimeter (Hunter Associated Labs. Inc., Reston, VA) that had been calibrated against a black and a white reference tiles covered with the same packaging materials as used for samples. The CIE L-(lightness), a- (redness), and b- (yellowness) values were obtained using an illuminant A. Area view and port size were 0.25 and 0.40 inches, respectively. An average value from both upper and bottom location on a sample surface was used for statistical analysis (CIE, 1976).

Sensory evaluation: A sensory test, using a consumer-type panel, comprised of 5 staff members from different departments, was employed to detect sensory differences samples within 6 months after storage in freezing condition. Each untrained panelist received four coded samples. Each member independently evaluated the turkey meat for taste, odor, color and flavor on a 5-point hedonic scale (1: extremely poor, 2: poor, 3: acceptable, 4: good and 5: excellent) (Lavrova and Krilova, 1975). Evaluation was performed under cool white fluorescent light in the sensory laboratory. The same meat samples were evaluated over storage times. The shelf life limit was defined as the point when 50% of the panelists rejected the sample.

Statistical analysis: The data were analyzed using analysis of variance to determine the effects of storage time on the parameters of meat quality: pH, WHC and SF. When the differences among types of storage time were significant ($p<0.05$), Tukey's test was carried out to check the differences between pairs of groups. Data were analyzed using the SAS/STAT (1988) statistical package (SAS/STAT, 1988).

RESULTS AND DISCUSSION

Microbiological properties: The mean log values of bacterial loads and coliform from samples packed of fresh turkey meat during storage at -18ºC are shown (Table 1). During storage, these microorganisms significantly decreased in samples. Mean bacterial loads and coliform counts were $7.1\times10^7\pm2.0\times10^6$ and $1.9\times10^7\pm7.1\times10^6$ (CFU/g), respectively. In this study, frozen storage was effective at decreasing total and coliform counts (Table 1). This reflects possible cross contamination during slaughter which has a significant effect on the bacterial

Table 1: Microbial means for turkey meat samples during frozen storage (-18ºC)

Time/cfu	Day 0	Day 60	Day 120	Day 180
Total aerobic plat count	$7.1\times10^{7}\pm2\times10^{6}$	8.99±0.44a	6.43±0.60b	5.50±0.81b
Coli form count	15.50±0.61a	16.12±0.55a	16.45±0.50a	17.06±0.46a

Table 2: Values (means±SEM) of some characteristics of turkey meat packed during storage time at -18ºC

Time/treatment	Day 0	Day 60	Day 120	Day 180
SF	10.26±0.62a	8.99±0.44a	6.43±0.60b	5.50±0.81b
TVN	15.50±0.61a	16.12±0.55a	16.45±0.50a	17.06±0.46a
PV	0.28±0.10a	0.30±0.05b	0.35±0.04c	0.75±0.10d

[a, b, c, d]: Values in the same column with different superscript are significantly different (p<0.05)

Table 3: CIE color values of aerobically packaged turkey breast meat during storage at -18ºC

Time/treatment	Day 0	Day 60	Day 120	Day 180
L* value	48.2±0.72a	47.98±0.37a	49.4±0.46a	52.1±0.70b
a* value	8.2±0.80a	7.1±0.59a	5.3±0.28a	4.5±0.41a
b* value	12.6±0.32a	11.9±0.85a	10.4±0.46b	10.1±0.21b

[a, b, c, d]: values in the same column with different superscript are significantly different (p<0.05)

Table 4: Sensory attributes of turkey meat during frozen storage (18ºC) after 6-month storage

Time/treatment	Appearance	Odor	Texture	Overall quality
Day 0	4.72a	4.16a	4.60a	4.51a
Day 60	4.19b	4.03ab	4.61ab	4.19b
Day 120	3.08c	3.39b	3.77ab	3.02c
Day 180	2.48d	2.54b	2.18b	2.66d

[a, b, c, d]: values in the same column with different superscript are significantly different (p<0.05)

status of carcasses (Borch and Arinder, 2002). It has been stated that many foods, particularly of animal origin, are heavily contaminated with organisms of various kinds (WHO, 1989). The results show that samples were coliform positive.

Physical and chemical quality:

Shear force: Many factors contribute to the eating quality of meat and the perception of taste, with tenderness being considered as one of the most important attributes (Wheeler *et al*., 1990; Koohmaraie *et al*., 1991). An objective measure of tenderness is the force required to shear a standardized piece of meat with low shear values being desirable. The tensile strength test is best suited for structural investigations rather than to predict sensory evaluation of tenderness. It is a useful test in conjunction with other methods. The test can be carried out on raw or cooked meat. Results will be affected by sample size and strain rate, but this latter effect is small. Shear forces data are shown (Table 2). Analysis of variance showed that aging of meat affected SF in all samples, as has been found in other studies where post mortem aging increased meat tenderness (Pinkas *et al*., 1978; Jeremiah *et al*., 1997). Shear force values tended to decrease (p<0.05) with ageing in turkey meat samples.

TVN value: Frozen storage significantly increased (p<0.05) their TVN contents (Table 2). The TVN is related to protein breakdown (Egan *et al*., 1981) and the observed increases may be attributed to the formation of ammonia or other basic compounds due to microbial activity (Banwart, 1981). The amounts of TVN and TBARS values were closely related, especially for turkey (Kim *et al*., 2002). TVN analysis can be employed as a practical and fast method for chemical analysis in turkey meat.

Peroxide value: Changes of PV are shown in Table 2. There was significant (p<0.05) difference between samples and PV increased with increasing of storage time. The lipid oxidation was attributed to the combination of free radicals with O_2 to form hydroperoxides. These results also agree with the findings of Kim *et al*. (Kim *et al*., 2002) and Lobovics *et al*. (Lobovics *et al*., 1992). In fact, the fat content and fatty acid composition are important in determining the extent of lipid oxidation during storage (Ahn *et al*., 1996; Ahn *et al*., 1998). It has been suggested that the lipids of turkey meat would be more susceptible to the development of rancidity than other meats due to its high content of polyunsaturated fatty acids, thus lipid oxidation may have an important influence on the stability of products containing turkey meat (Lee and Ahn, 1977; Sinclair and O'Dea, 1987).

Color measurements: L*-values increasedin turkey breast meat and the degree of color increased (Table 3). Although b*- and b*-values were not much changed by storage. During the storage, the a*-values of turkey breast samples decreased significantly (p<0.05) after 2 months of frozen storage (-18ºC). This result is consistent with report of Lynch (Lynch *et al*., 1998) who declared that heme pigments were oxidized during the storage period under aerobic conditions.

Sensory properties: The camel meat was also evaluated for changes in surface color, texture, and odor by semi-trained panelists. The sensory attributes of turkey meat

during storage at -18°C are shown (Table 4). Storage time effect within treatment indicated that surface discoloration increased ($p<0.05$) especially at day 60 in packed samples. Panelists gave similar preference scores for samples which indicated that all were highly acceptable as judged by appearance, odor texture and overall quality. Moreover, samples gave similar acceptable scores for the sensory attributes during frozen storage (Table 4). Since, there was no significant difference in sensory quality and chemical characteristics during frozen storage, controlling contamination in turkey meat and enhancing its shelf-life to 2 months without chemical and sensory quality changes is possible. In another word, this method will enable food processors to deliver larger amounts of turkey meat of high quality with extended shelf-life and improvement of storage safety and makes turkey meat suitable for commercial applications and critical conditions.

CONCLUSION

In this study we have observed the evolution of the main parameters that affect turkey meat quality (TVN, PV, microbial load and color). In general, there were no differences during 2 months storage at -18°C for color, TVN and PV. Tenderness increased with aging time. In addition, decrease of shear force suggests that it not possible to maintain initial meat quality of this breed. As a result, the packed camel meat under low temperature developed less off-flavors and essentially no rancidity within the storage time tested (2 months). In summary, storage of packed meat under frozen condition enhanced product shelf life for 2 months without undesirable and detrimental effects on its sensory acceptability.

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