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QUALITY CHANGES DURING REFRIGERATED STORAGE OF RABBIT MEAT

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SUMMARY

Rabbit meat obtained from 18 New Zealand white rabbits were subjected to refrigerated storage at 3 ± 1°C and examined after 1, 5, 7, 10 & 12 days for pH value, cooking loss %, sensory properties, aerobic mesophilic count (AMC), psychrophilic count, lactic acid bacteria count (LAB) & thiobarbituric acid-reactive substances (TBARS). PH revealed a variation in its value throughout the storage period. Cooking loss % was significantly increased ($P < 0.05$) throughout storage period, while storage significantly decreased sensory prosperities. A significant increase ($P < 0.05$) was detected among all microbial counts and TBARS throughout the storage period. Data obtained suggest that rabbit meat should be rejected at the 10th day of refrigerated storage due to significant alterations in sensory attributes and unacceptable microbial counts.

INTRODUCTION

Rabbit meat production is important in the mediterranean area and many other countries. Rabbits have high fertility rates with rapid rates of growth, a high feed efficiency and early marketing age, high muscle-bone ratios, and require a small land area. Rabbit meat is a highly digestable, tasty, low-calorie food with high protein content and low levels of fat, cholesterol and sodium, making it a very useful food in human diets (Rao *et al.* 1978; Fernandez-Espla & O'Neil, 1993). Consequently, rabbit meat is considered a leaner and healthier meat than beef, lamb or pork (Luke-fahr *et al.* 1989; Enser *et al.* 1996; Lee & Ahn, 1997).

Meat quality can be evaluated objectively by measuring some biophysical or biochemical traits, however, sensory properties are the most important attributes of rabbit meat to consumers such as colour, texture and flavour (Dalle Zote, 2002). Several studies have been conducted on the microbiological quality of red meat, poultry

and their products (WHO, 1986, 1989; IAEA, 1993; Anon, 1996; CDC, 1999; Huffman, 2002), however there's some lack of information concerning microbiological and sensorial quality of rabbit meat (Badr, 2004).

Although rabbit meat production is a very important livestock activity and its industry is highly developed, rabbit carcasses are obtained, processed, and stored like those of other meat animals. Therefore, the present work was undertaken to extend the knowledge of some quality attributes d of rabbit meat during refrigerated storage.

MATERIALS AND METHODS

Eighteen New Zealand white rabbits at live weights of 2.25-2.45 Kg were slaughtered under hygienic conditions in a small plant, then the skin and viscera were immediately removed. Carcasses overwrapped with oxygen-permeable film and stored aerobically at 3±1°C for 24h. After 24h storage, carcasses were hand deboned, and the obtained meat from each carcass was also overwrapped separately with oxygen-permeable film and stored aerobically at 3±1°C where it subjected to the following examination after 1, 5, 7, 10, 12 days of storage post-mortem.

pH measurement:

At each sampling time ten grams of each sample were homogenized with 90 ml deionized water for 2 minutes and the pH was measured using digital pH meter (Suntex TS-1) with probe type combined electrode (Ingold) through immersing the electrode directly into the mixture. Three readings were recorded and the average was calculated (Allen *et al.*, 1997)

Cooking Loss:

50 grams from each sample at every sampling day were wrapped in aluminium foil, placed in roasting pans and cooked at 175°C in a conventional preheated electric oven to 80°C internal temperature using a hypodermic probe-type thermocouple (Model HVP- 2- 21- V2- TG- 48- OCT- M. Omega, Stanford, CT). Cooked samples were allowed to cool then were weighed and percentages of cooking loss were determined.

Sensory evaluation:

The sensory attributes were evaluated by a scoring test using nine-point hedonic scale where 9 = extremely intensive flavour, extremely juicy, extremely tender & extremely acceptable and 0 = extremely bland, extremely dry, extremely tough, extremely unacceptable. Five assessors were selected from the staff members of the Department of food Hygiene and Control, Faculty of Veterinary Medicine, Cairo University, Egypt. They received a preparatory session prior to testing so that each panelist could thoroughly discuss and clarify each attribute to be evaluated. Samples were presented at room temperature on a preheated plate to prevent its cooling.

Bacterial analysis:

Ten grams from each separated rabbit meat group at each examination day were removed aseptically and homogenized with 90 ml ringer's solution (Merck) in a stomacher (Lab-blender 400, Seward, UAC house friars Road, London SE 19 UG. Model No. 6021) for 2 minutes to prepare the initial 1/10 dilution. From the resulting dilution, appropriate serial dilutions were prepared using the same diluent (ICMSF, 1978). Dilutions were spread plated (two plates per dilution and incubation temperature) onto plate count agar (oxoid), and incubated at 30°C for 2 days and 4.5°C for 14 days for total aerobic mesophilic and psychrophilic bacterial counts, respectively (Harrigan, 1998). Lactic acid bacteria (LAB) were enumerated by the pour-overlay method using de Man Rogosa Sharpe (MRS) agar (oxoid) plates which were incubated at 30°C for 3 days.

Oxidative stability:

Thiobarbituric acid-reactive substances (TBARS) were determined according to the method of Du and Ahn (2002). Five grams from each rabbit meat sample at each examination day were homogenized with 15 ml of deionized distilled water. One milliliter of the meat homogenate was transferred to a test tube containing 50 µL of butylated hydroxytoluene (7.5%) and 2 ml of thiobarbituric acid (TBA)-trichloroacetic acid (TCA) (15 mM TBA-15% TCA) were added.The mixture was vortexed and then incubated in a boiling water bath for 15 min to develop colour .Then sample was cooled in cold water bath for 10 min, vortexed again, and centrifuged for15 min at 2500 x g. The absorbance of the resulting supernatant solution was determined at 531 nm against a blank containing 1 ml of deionized water and 2 ml of TBA-TCA solution. The amounts of TBARS were expressed as mg of malonaldehyde per Kg of meat.

Statistical analysis:

The statistical package SPSS 17.0 for windows was used to explore the statistical significance of the results obtained. One-way analysis of variance (one-way ANOVA) using Duncan test was carried out to verify the existence of statistically significant difference throughout the storage period. A confidence interval at 95% level ($P<0.05$) was considered.

RESULTS AND DISCUSSION

PH Measurement

The mean PH value after 24 hours post mortem of the examined samples was 5.76 ± 0.18 (Table 1). Nearly similar results were obtained by Hernandez *et al.* (2000) Combes *et al.* (2008). In other studies a more higher values were obtained (Ramirez *et al.*, 2004; Rodriguez- Calleja *et al.*, 2004 & 2005). A significant increase was detected at the 5th day of storage period (6.08 ± 0.13), followed by a

significant decrease (5.76 ± 0.11) (P<0.05) at the 7th day. Finally, at the 12th day the mean pH value reached 5.96 ± 0.1. Cabanes – Roiron *et al.* (1994) achieved nearly similar pH variation which can be explained by two contemporary mechanisms, a rise in the level of ammonia, amines and other basic substances due to bacterial activity, which alkalinizes the meat, and the formation of free fatty acids, which tends to acidify it (Sunki *et al.*, 1978; Nychas *et al.*, 1998; Dalle Zotte, 2002).

Table (1): pH value of rabbit meat during refrigerated storage

Storage days	Min	Max	Mean*	± SD
1	5.58	6.07	5.76^{ac}	0.18
5	5.91	6.27	6.08^{bc}	0.13
7	5.63	5.96	5.76^{ac}	0.11
10	5.67	6.35	5.97^{abc}	0.26
12	5.83	6.09	5.95^{abc}	0.10

*Mean with different letters are differ significantly (P< 0.05).

Cooking loss

Results of cooking loss percentage revealed a significant increase (P < 0.05) throughout the storage period. At the 1st day it was 32.67% ± 5.47 and it reached 46.47% ± 3.00 at the end of storage period (Table 2).

Table (2): Cooking loss % of rabbit meat during refrigerated storage

Storage days	Min	Max	Mean*	± SD
1	24	38	32.67^{ab}	5.47
5	32	38	35.67^{abc}	2.94
7	36	46	40.67^{bc}	3.93
10	42	48	45.00^{c}	2.45
12	42	50	46.47^{c}	3.0

*Mean with different letters are differ significantly (P< 0.05).

Sensory evaluation:

Meat sensory properties are crucial for the consumers choice. The most significant variables include texture (tenderness and juiciness) and flavour (taste, smell and aroma).

Table (3) declared a significant decrease (P < 0.05) in the mean values for tenderness, juiciness, flavour and overall acceptability scores throughout the storage period. At the 12th day, all samples were organolepticaly rejected with mean values of 2.83 ± 0.41, 4.67 ± 0.52, 3.17 ± 0.76 and 2.83 ± 0.41 respectively. Soultos *et al.* (2009) observed an initial signs of spoilage and off-flavour development after the 6th day of storage of rabbit carcasses and the samples were totally rejected in the 8th day.

Table (3): Sensory evaluation of examined rabbit meat samples during refrigerated storage

Storage days	Tenderness	Juiciness	Flavour	Overall acceptability
1	8.5 ± 0.55^{a}	8.5 ± 0.55^{ab}	8.5 ± 0.55^{ab}	8.5 ± 0.55^{a}
5	8.17 ± 0.41^{a}	8.17 ± 0.41^{abc}	8.17 ± 0.41^{abc}	8.17 ± 0.41^{a}
7	7.00 ± 0.0^{b}	7.33 ± 0.52^{bc}	7.3 ± 0.52^{bc}	7.00 ± 0.0^{b}
10	5.83 ± 0.41^{c}	6.00 ± 0.89^{d}	5.67 ± 0.52^{d}	5.83 ± 0.41^{c}
12	2.83 ± 0.41^{d}	4.67 ± 0.52^{e}	3.17 ± 0.75^{e}	2.83 ± 0.41^{d}

Each value represents the mean ± standard deviation
Mean with different letters are differ significantly ($P < 0.05$).

Bacterial analysis:

The safety of meat has been at the forefront of societal concerns in recent years, mean while safety and shelf life of meat are limited by microbial growth. Throughout the refrigerated storage all microbial counts on all rabbit meat samples significantly increased ($P < 0.05$) as shown in table 4. Initial mean counts for aerobic mesophilic bacteria (AMC), psychrophilic bacteria and lactic acid producing bacteria (LAB) were found to be high as their mean Log_{10} counts reached 5.03 ± 0.60, 4.8 ± 0.54 and 3.06 ± 0.12 cfu/g, respectively. This might reflect the possible cross contamination during slaughter which has a significant effect on the bacterial status of carcasses.

Nearly similar results were reported by Bobbitt (2003) (4.79 Log cfu/g) and Rodriguez-Calleja *et al.* (2005) (5.0 Log cfu/g) for mean values of AMC. On the contrary a lower results were achieved by Khalafalla (1993), Rodriguez-Calleja *et al.* (2004) & Kohler *et al.* (2008) for AMC (4.1cfu/g, 4.1cfu/g&3.3 Log cfu/cm^2 respectively). Meanwhile the mean log for both AMC and psychrophilic bacteria count in this study were lower than that obtained by Badr (2004) (6.02, 5.88cfu/g respectively.

Concerning LAB, Rodriguez-Calleja *et al.* (2004) and Soultos *et al.* (2009) recorded slightly higher results (3.50 ± 0.44 and 3.56 ± 0.69 Log cfu/g).

At 7th day of storage, the mean Log_{10} counts for aerobic mesophilic, pyschrophilic and lactic acid bacteria were significantly increased reaching 6.15 ± 0.55, 6.27 ± 0.57 and 4.79 ± 0.45 Log cfu/g respectively. It is established that microbial levels of 6-7 Log cfu/g are critical for the spoilage of meat (Hernandez, 2008). Similar results were obtained by Rodriguez-Calleja *et al.* (2005) but after 5 days of storage of rabbit carcasses at 3°C, however Soultos et al. (2009) reported similar findings for AMC and LAB log counts.

Table (4): Aerobic mesophilic count (AMC), psychrophilic count and lactic acid bacteria (LAB) of rabbit meat during refrigerated storage.

Storage days	AMC (log_{10} cfu/g)				Psychrophilic count (log_{10} cfu/g)				LAB (log_{10} cfu/g)			
	Min	Max	Mean*	±SD	Min	Max	Mean*	±SD	Min	Max	Mean*	±SD
1	4.28	5.96	$5.03^{a,b}$	0.60	4.0	5.34	4.8^{a}	0.54	3	3.3	$3.10^{a,b}$	0.12
5	4.34	5.92	$5.10^{a,b}$	0.57	4.78	6.08	5.20^{a}	0.52	3	3.3	$3.07^{a,b}$	0.12
7	5.18	6.90	6.15^{b}	0.55	5.48	7.18	6.27^{b}	0.57	4.18	5.36	$4.79^{b,c}$	0.45
10	6.54	7.87	7.30^{c}	0.59	5.6	7.51	6.46^{b}	0.63	4.04	6.34	$5.47^{b,c}$	0.82
12	6.84	7.99	7.50^{c}	0.50	5.77	7.72	6.65^{b}	0.64	5.08	6.82	5.88^{c}	0.71

*Mean with a different letter are different significantly ($P< 0.05$).

Oxidative stability:

Refrigerated storage may worsens some chemical parameters-indicators of meat biochemical criteria, such as TBARS value which is an indicator of lipid oxidation.

It is clearly evident from table 5 that TBARS value increased significantly ($P < 0.05$) during refrigerated storage of rabbit meat samples. After 12 days of storage it reached 0.56 ± 0.28 mg malonaldehyde /kg. These results disagree with that obtained by Badr (2004) during refrigerated storage of minced rabbit meat which reached a TBARS value of 0.697 ± 0.015 after 6 days. Meat contains several natural antioxidants such as catalase, superoxide dismutase and glutathione peroxidase (GSH-Px) (Hernandez, 2008). Studies on meat of several species (Pradhan *et al.*, 2000) indicate that endogenous antioxidant enzymes could potentially delay the onset of oxidative rancidity in refrigerated stored meat. Indeed, GSH. Px could have an important role controlling lipid oxidation due to its high activity in rabbit meat when compared to other species (Hernandez *et al.*, 2002). There are other endogenous antioxidants such as histidine-containing dipeptides, carnosine and anserine, but content vary according to species (Decker *et al.*, 2000).

From the aforementioned results it can be suggested that rabbit meat must be rejected after 10 days of storage where AMC and psychrophilic log counts had risen to 7.3 ± 0.60, 6.46 ± 0.63 Log cfu/g respectively. Moreover sensorial data became clearly affected after 10 days of storage. Soultos *et al.* (2009) rejected chilled rabbit carcasses on the 8th day of storage when AMC reached 7.88 ± 0.73 log cfu/g. These differences could be explained by differences in initial microbial counts. Other authors estimated shelf life of rabbit carcasses stored at 3°C according to both appearance and odor to be 6.8 days where AMC reached 8 Log cfu/g (Rodriguez-Calleja *et al.*, 2005).

Table (5): Thiobarbituric acid-reactive substance (TBARS) (mg malonaldehyde/kg) in rabbit meat during refrigerated storage.

Storage days	Min	Max	Mean*	±SD
1	0.03	0.18	0.12[a]	0.06
5	0.08	0.28	0.2[a]	0.08
7	0.06	0.34	0.24[a]	0.11
10	0.10	0.42	0.30[a]	0.12
12	0.12	0.93	0.56[b]	0.28

*Mean with a different letter are different significantly (P< 0.05).

In conclusion rabbit meat can be stored under refrigerated storage for up to 10 days at which AMC and psychrophilic log counts were increased to unacceptable limits, mean- while sensory attributed seemed to be clearly affected. Therefore AMC and psychrophilic counts could be a good indicators for rabbit meat shelf life in conjunction with sensory attributes. These results also may help rabbit meat processors and governmental agencies taking in consideration the importance of slaughter hygiene to ensure both public health protection and meat quality improvement.

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تغيرات جودة لحوم الأرانب أثناء تخزينها بالتبريد

هيام عبد العال منصور حسن

قسم الرقابه الصحيه علي الأغذية ـكلية الطب البيطرى - جامعة القاهرة

فى دراسة تهدف إلى معرفة التغيرات التى تحدث فى خصائص جودة لحوم الأرانب أثناء تخزينها بالتبريد عند درجة حرارة ٣ ± ١°م. تم فحص اللحوم الناتجة من ١٨ أرنب نيوزيلندى أبيض بعد تخزينها مبردة وفحصها بعد ١، ٥، ٧، ١٠، ١٢ يوم وذلك لمعرفة قيمة تركيز أيون الهيدروجين، نسبة فقد الوزن نتيجة للطهى، الخصائص الحسية، عدد البكتريا الهوائية، عدد البكتريا المحبة للبرودة، عدد بكتريا حامض اللاكتيك وأخيراً قيمة حامض الثيوباربيتيوريك. وقد أظهرت نتائج قيمة درجة تركيز أيون الهيدروجين اختلافاً خلال فترة التخزين. أما نسبة الفقد فى الوزن نتيجة الطهى فقد سجلت زيادة معنوية خلال فترة التخزين فى حين أن التخزين أدى إلى انخفاض معنوى فى الخصائص الحسية للحوم الأرانب المفحوصة. وأخيرا سجل كلا من العد البكتيرى لكل الميكروبات المذكورة سابقا وقيمة حامض الثيوباربيتيوريك زيادة معنوية خلال فترة التخزين. ومن خلال هذه النتائج يمكننا استخلاص أن لحوم الأرانب المبردة يجب أن يتم استبعادها لعدم صلاحيتها للاستهلاك الآدمى وذلك بعد مرور عشرة أيام وذلك لوجود تغيرات واضحة وشديدة فى الخواص الحسية وأيضا ازدياد العد البكتيرى إلى الحدود الغير مسموحة.