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Shelf Life and Microbiological Quality of Eviscerated Broiler Carcasses in the State of Kuwait

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ABSTRACT. Temperatures in display refrigerators of 42 food outlets were monitored to determine the shelf life of chilled poultry meat in Kuwait. Temperature fluctuations were also measured in 15 food outlets. Data showed that market storage temperatures were high, averaging 8-10°C in more than 50% of the outlets surveyed and the temperature fluctuation in display refrigerators ranged between 1 and 6°C. Data on the shelf life of chilled poultry meat stored under simulated market storage temperatures showed that the spoilage rate was directly proportional to the storage temperature and storage period. The shelf life after processing was about 7, 5 and 4 d at 4, 7 and 9°C, respectively. Incipient spoilage was first observed when the log count of spoilage reached > 7.2 CFU/ml rinse. This was accompanied by changes in organoleptic characteristics (*e.g.*, poor appearance, off-odors, slime formation and discoloration), increased values of total volatile nitrogen compounds, free fatty acids and decreased values of extract release volume. Data also showed high initial counts of *E. coli* and coliforms, indicating poor sanitation during slaughtering. As for food-poisoning microorganisms, 60-80% of the samples tested positive for *Salmonella,* whereas *Campylobacter* was detected in all samples. The initial log count of *Staphylococcus aureus* was 3.4 CFU/ml. This count did not increase substantially during storage at 4-7°C, but increased rapidly to > 4.4 CFU/ml after 3 d of storage at 9°C.

Key words: Poultry, storage, spoilage, psychrophiles, pathogens.

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In Kuwait, nearly half, *i.e.*, 10.0-12.5 million, of locally produced boilers are sold chilled. The chilled broiler carcasses, however, generally have a short shelf life, which is a major problem for the poultry industry.

Fresh, unprocessed poultry meat, like many other perishable foods, usually undergoes quick microbial spoilage under chilled storage conditions (Pooni and Mead 1984, Mead 1990). Spoilage microorganisms grow well on the surface, causing off-odors, slime and discoloration. These characteristics usually appear when the spoilage bacteria reach log 7.2 to 8.0 CFU/g or cm^2 of meat or skin, respectively (Jay and Shelef 1976, Mead 1982). In addition, poultry and poultry products are susceptible to contamination by organisms of sanitary and public health concern, such as *Escherichia coli* and *coliforms, Salmonella, Campylobacter, Staphylacoccus aureus, Clostridium perfringens* and *Yersinia enterocolitica* (Jay 1978, Cunningham 1982).

Several methods for determining the freshness or spoilage of meat have been proposed and claims made for their practical value (Dainty *et al.* 1983, Gallo *et al.* 1988). The most commonly used methods depend on measuring total viable counts, also called aerobic plate counts. Other methods involve detecting certain metabolites produced by growth and multiplication of spoilage organisms, such as volatile sulphur compounds (*i.e.,* hydrogen sulphide, methanethiol and others), volatile nitrogen compounds, primary aliphatic alcohols, fatty acids and other low molecular weight substances. In addition, meat spoilage can be assessed by measuring the extract release volume, the change of pH and dye reduction tests; however, most of these methods can only be used at a relatively late stage of spoilage when strong odors are already noticeable.

This paper reports on the microbiological shelf life of locally produced fresh chicken carcasses when stored in the laboratory under different low temperatures simulating local market storage conditions. The prevalence and/or proliferation of selected organisms affecting sanitation and public health in chilled carcasses are also reported.

Materials and Methods

Storage Temperature

During storage and handling of poultry products, the temperature is considered the most important factor influencing microbial growth, and thus, the shelf life of fresh poultry meat (Barnes and Thornely 1966, Barnes *et al.* 1979, Jay 1986). Since no data were available on local market storage and handling conditions in Kuwait, a market survey was completed in Kuwait City. Forty-two food outlets, representing most of the food outlets in Kuwait City that handle chilled poultry meat, were visited and the temperatures in display refrigerators and bulk storage cold stores were determined. The storage temperatures of chilled poultry meat were measured by digital thermometers (± 1 °C) in display cabinets of food outlets handling these products. In addition, temperature fluctuations were measured by continously monitoring the storage temperature in display cabinets of selected food outlets (15 supermarkets). Measurements were taken over 72 hours by a temperature chart recorder (Chino type ES 200-06, Tokyo, Japan).

Poultry Samples and Storage

Two hundred chicken carcasses (Grade A), about 1 kg each, were obtained the day after processing, from a major modern commercial slaughterhouse. They were divided into three groups and stored at 4,7 and 9°C, respectively. These temperatures represented the actual market storage temperatures recorded during the market survey. Five to ten carcasses at each storage temperature were removed from the refrigerators at 0, 3, 4, 5, 6, 7, 8, 9, 10 and 11 d of storage in the laboratory and were sampled for microbiological, chemical and organoleptic analysis.

Chicken Sampling

The carcass rinse method was used to obtain samples for microbiological analysis. This method was chosen because it is non-destructive, easy and quick to use (Malimann *et al.* 1958, Kinsley and Mountney 1966, Cox *et al.* 1976, Lillard 1988). Moreover, the carcass rinse method has the advantage of sampling the entire exposed surface of the carcasses, which is essential for the detection of specific microorganisms such as *salmonella* (Avens and Miller 1970, ICMSF 1986, Cox *et al.* 1981). The following sampling technique was used: Chicken carcasses were halved and one half was placed in a sterile polyethylene bag (Seward Stomacher 400, England) containing 0.2% sterile lactose broth (1:1 w/v). The bags were shaken vigorously for 1 min and the aliquots transferred into sterile screw cap dilution bottles. A decimal dilution series was set up for each aliquot and used for microbiological analysis. The other half was used for chemical analysis.

Microbiological Analysis

The shelf life of chicken carcasses stored at different temperatures (4, 7 and 9 °C) in the laboratory was assessed by measuring the APC for psychrotrophic bacteria and selected microbial spoilage indicators or metabolites (*i.e.,* TVN, ERV, FFA and PV). Spoilage microorganisms were determined by measuring the aerobic plate counts (APC) for psychrotrophic bacteria. This measurement was obtained by spreading 0.1 ml of each dilution onto APC-agar (Oxoid, UK) and incubating for 7 d at 4 °C. All plates with 20 to 300 colonies were counted and the logarithmic mean of five to ten samples was calculated. The results were calculated as log colony forming units (log CFU) per ml carcass rinse.

Escherichia coli and coliform bacteria were detected by spreading 0.1 ml of each dilution on Levin's eosin-methylene-blue (L-EMB) agar (Difco), and colony counting after 1-2 of incubation at 37 °C. Typical *E. coli* colonies were confirmed as outlined by ICMSF (1978).

Staphylococcus aureus were examined by spreading 0.1 ml of each dilution onto Baird-Parker egg yolk-tellurite emulsion medium (Difco/Oxoid). After 1-2 d of incubation at 37°C, typical *S. aureus* colonies were confirmed using coagulase (rabbit plasma, Difco) and DNASE tests (Oxoid), as outlined by ICMSF (1978) and Collins (1984).

Salmonella was detected by a series of pre-enrichment and selective enrichment techniques, as described by ICMSF (1978). Selective enrichment was carried out using selenite cystine (SC) or tetrathionate (TT) broth (Oxoid). *Salmonella* colonies were cultured by spreading 0.1 ml of SC or TT-culture onto *Salmonella-Shigella* agar (Oxoid) and modified lysine-iron agar (MLIA), prepared as described by Bailey *et al.* (1988). After 24 h of incubation at 37 °C, suspected *Salmonella* colonies were identified biochemically as outlined by ICMSF (1978) and typed serologically at the Public Health Laboratory (PHL), Kuwait.

Campylobacter was isolated by spreading 0.1 ml of each dilution onto a *Campylobacter* base-agar (Difco) supplemented with 7% horse blood and Skirrow's selective supplement (Oxoid). Plates were incubated at 43°C for 1-2 d in a microaerophilic atmosphere (85% N_2, 10% CO_2 and 5% O_2), using gas generating kits (Oxoid; BR 56). Suspected *C. jejuni* colonies were identified morphologically and biochemically as described by Blaser (1982) and Lior (1984).

Chemical Analysis

The measurement of free fatty acid (FFA) contents, peroxide value (PV), total volatile base nitrogen (TVN) and the extract release volume (ERV) were all determined according to the methods as described by Egan *et al.* (1981) and as described by Sawaya and Abu-Ruwaida (1989).

Sensory Evaluation

Sensory evaluation of the poultry caracasses was done by the research team (five to six judges). Several parameters, including color, odor, texture and overall appearance, were evaluated using a hedonic scale from 0 to 10, with 10 being 'extremely good' and 0 being 'unacceptable' (Larmond 1977).

Statistical Analysis

Statistical analysis and numerical calculations were performed using the multivariate hypothesis testing (Morrison 1976) and procedures provided by SAS (1985), respectively.

Results and Discussion

Market Storage Temperature

Results (Fig. 1) showed that chilled poultry meat was stored in display refrigerators at 4 °C or below, in only 4/42 (9.5%) food outlets. In the rest of the food outlets, the display refrigerator storage temperatures were 4-7 °C in 15/42 (35.7%), 7-10 °C in 18/42 (42.9%) and > 10 °C in 5/42 (11.9%). Therefore, storage conditions in market display refrigerators are substantially higher than the recommended normal chilling temperatures of 4 °C and are considered inadequate. Storage temperatures in the cold stores (bulk storage) surveyed were less than 3 °C in 2/7 (28.6%), 3-5 °C in 2/7 (28.6%), 7-8 °C in 2/7 (28.6%) and > 8 °C in 1/7 (14.3%) (Fig. 1).

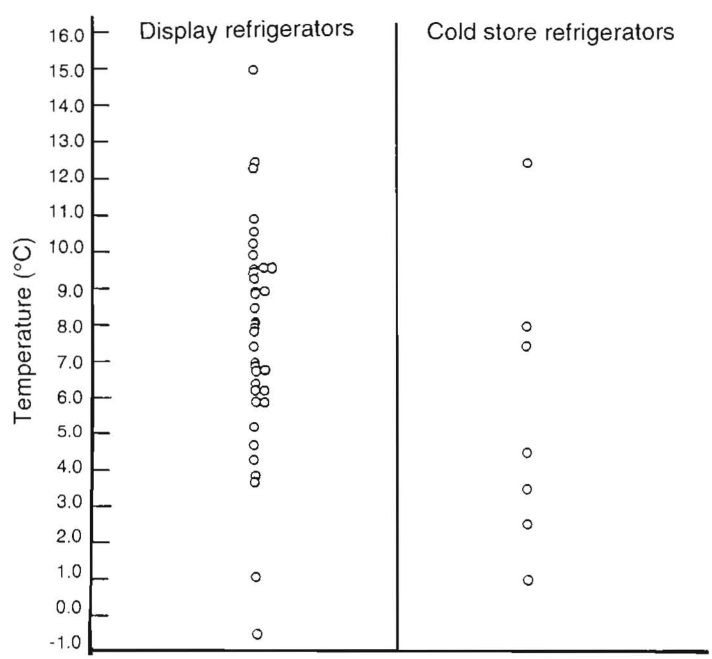

Fig. 1. Number of display and walk-in refrigerators at prevailing market temperatures.

The temperature fluctuations in chilled poultry meat display cabinets were determined in 15 cooperatives and supermarkets for 3-4 d each. Measurements were taken by an automatic temperature chart recorder with a 7 d recording chart. Two thermo-couples were installed at two different locations in the display cabinets, and two temperature readings were obtained. Data obtained (Fig. 2) showed that the temperature fluctuations were substantial, and varied from one food outlet to another.

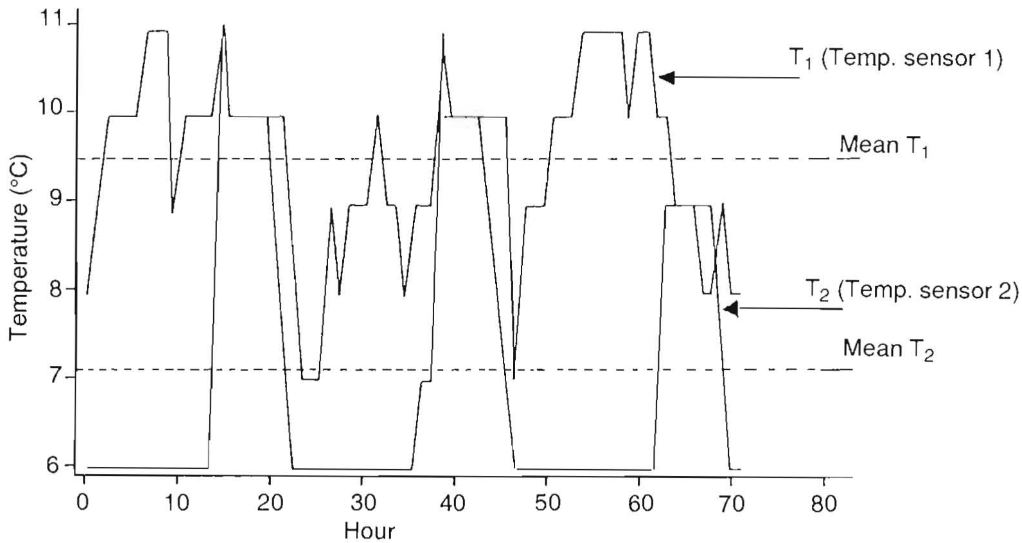

Fig. 2. Temperature fluctuations at display refrigerators.

Temperatures recorded by the two thermocouples were always different. The difference was substantial and ranged between 1 and 6 °C. This indicated uneven distribution of cooling in the display refrigerators on the same shelf and on the different shelves where the poultry meat was stacked, with the coldest point closest to the source of cold air. In general, the following conditions were observed:

1. In 9/15 food outlets, the temperature ranged between 7 and 10.5 °C during a 3 d period, with the rest being less than 7 °C.
2. An increase in temperature was always associated with the loading of fresh chicken during the mornings and afternoons in all the food outlets surveyed. The average duration of this temperature increase was 3-4 h and, in some, > 4 h, depending on the load.

3. Overall poor air-conditioning inside the markets allowed for a cold air loss from the display refrigeration units, especially during the hot hours of the day.
4. Increase in temperature during peak shopping periods that was probably caused by human heat generation.
5. Overloading of the shelves of the refrigerated display cabinets, thus decreasing cold air circulation.
6. Inefficient cooling systems, where any extraneous factor such as loading or poor air-conditioning causes a significant temperature fluctuation.
7. 1/15 food outlets surveyed, the cooling system was shut off during the evening from 11.00 p.m. to 7.00 a.m. for the three days that temperature fluctuations were monitored.

Shelf Life

Fig. 3 shows data of spoilage organisms expressed as psychrotophic bacterial counts in carcasses stored at 4, 7 and 9 °C.

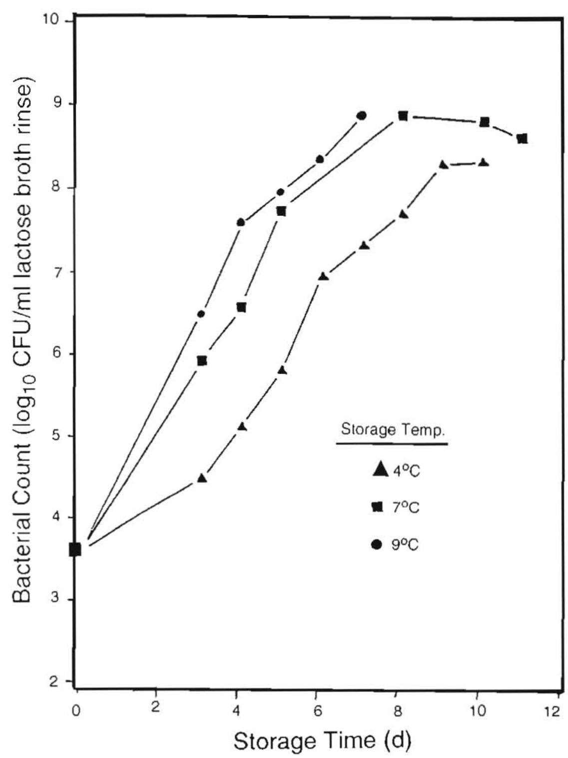

Fig. 3. Total counts of psychrotrophic bacteria at different storge temperatures.

The initial counts, determined on day one of processing, were log 3.6 CFU/ml of lactose broth rinse. These counts, however, increased as expected with increased storage duration and temperature. They reached the upper limit of acceptability (log 7.0 CFU/g) recommended for chilled meat by ICMSF (1986) approximately 6-7, 4-5 and 3-4 d after processing when stored at 4, 7 and 9 °C, respectively. At this time, no spoilage was found in any of the caracasses. Incipient spoilage was first observed when the log CFU counts/ml reached approximately 7.2. This was accompanied by changes in the overall organoleptic characteristics such as poor appearance, odor, slime formation and discoloration (Table 1).

Table 1. Sensory and organoleptic properties of chilled poultry meat during storage at different temperatures

Storage Time (d)	Evaluation*											
	4°C				7°C				9°C			
	O	C	T	OL	O	C	T	OL	O	C	T	OL
0	10	10	10	10	10	10	10	10	10	10	10	10
3	10	10	7	7	10	7	7	7	5	5	5	5
5	7	7	7	7	5	5	2	2	1	1	0	0
6	7	5	5	5	5	2	2	2	0	0		
7	5	5	2	2	ND	ND	ND	ND				
8	2	2	1	1	1	1	1	1				
9	2	1	1	1	0	0	0	0				
10	1	1	1	1								
11	0	0	0	0								

* Scores: 10, very good; 7, good; 5, fair; 2, poor; 1, very poor; 0, unacceptable.
Symbols: O, odor; C, color; T, texture; OL, overall appearance.
Values represents the means of 5-10 samples.
ND = Not determined.

These occurred about 1 and 3 d before the 7 d shelf life recommended by the poultry producers in Kuwait had elapsed for those stored at 7 and 9 °C, respectively, indicating that the higher the temperature, the earlier the incipient spoilage. These findings compare well with those reported by Sawaya and Abu-Ruwaida (1989) and by other investigators, who found that incipient spoilage of chilled poultry was established when the log number of spoilage bacteria reached 7.2-8/g or cm^2 (Aryes 1960, Dainty *et al.* 1985). Moreover, data obtained from similar studies carried out in our laboratory under the same storage conditions as indicated above showed that *Pseudomonas* spp. accounted for more than 80% of the psychrotrophic bacteria found. This finding agrees with those previously reported by other investigators, who found that *Pseudomonads* were the predominant organisms responsible for the spoilage of poultry meat during refrigerated storage under aerobic conditions (Cox *et al.* 1975, Eribo and Jay 1985).

Table 2 presents the effect of storage temperature on certain microbial spoilage indicators or metabolites, such as total TVN compounds, ERV, FFA and PV.

Table 2. Effect of storage temperature on the production of microbial spoilage indicators or metabolites*

Storage Time (d)	TVN (mg N/100 g)	ERV (ml)	FFA (%)	PV (meq/kg)
Storage at 4°C (n = 8)				
0	9.70	12.00	0.51	0.48
3	17.10	11.75	0.54	0.78
4	20.90	11.50	0.60	0.74
5	22.00	11.00	0.62	0.97
6	20.90	11.50	0.67	0.89
7	23.50	10.25	1.18	0.92
8	27.20	11.00	1.30	1.28
9	28.90	10.00	1.34	1.36
10	29.80	9.25	1.52	1.50
11	31.00	7.00	1.64	2.20
Storage at 7°C (n = 8)				
0	9.70	12.00	0.51	0.48
3	18.10	8.60	0.65	0.95
4	27.15	8.50	0.74	0.98
5	29.00	8.50	0.89	1.34
6	33.00	7.25	1.34	1.76
7	34.30	6.25	1.50	2.45
8	41.30	6.00	1.80	2.67
Storage at 9°C (n = 8)				
0	9.70	12.00	0.51	0.48
3	22.90	7.25	0.80	0.90
4	27.70	6.25	1.18	2.50
5	28.80	5.75	1.58	3.60
6	33.50	5.00	1.80	4.30
7	42.50	ND	2.00	5.70
8	50.20	ND	ND	6.20

*TVN, total volatile nitrogen; ERV, extract release volume; FFA, free fatty acids;
ND = Not determined; n = Number of samples; PV = Peroxide value.

The levels of TVN compounds were relatively high initially, increased rapidly after 3-4 d of storage at all storage temperatures (4, 7 and 9 °C), and reached higher than the acceptable levels (16.5-19.7 mg/100 g meat) recommended by Egan *et al.* (1981). This may be due to the microbial metabolites secreted in the medium because of increased bacterial growth (Gill 1983, Gallo *et al.* 1988, Viehweg *et al.* 1989a, Viehweg *et al.* 1989b).

The ERV value (ml) decreased rapidly in carcasses held at 9 °C after 4-5 d of storage. However, in those carcasses stored at lower temperatures, the ERV values were still within acceptable limits after 4 d of storage; they decreased after long periods of storage at 4 °C (11 d), followed by 7 °C (6-8 d), concomitant with the proliferation of spoilage organisms in the meat. These results agree with those of Jay (1965) and Jay (1986) and confirm our previous laboratory findings on the strong relationship between bacterial counts/spoilage and ERV values (Sawaya and Abu-Ruwaida 1989).

The FFA levels were generally low in fresh poultry meat. During storage at a high temperature (9 °C), the FFA content increased rapidly, reaching about 1.2% on the fourth day of storage. At 4 and 7 °C, however, the FFA content increased slowly, reaching the upper acceptable limits of 1.2-1.5% (Egan *et al.* 1981) on 7-10 d and 6-7 d of storage, respectively. These results indicate a clear relationship between the spoilage or bacterial count and the FFA content of poultry meat. Similar findings have been recently reported by Viehweg *et al.* (1989b), who found that fatty acid esters were low in fresh chicken carcasses and steadily increased with longer storage at 4 °C. The same authors also concluded that certain fatty acids could be considered as indices of spoilage.

The effect of storage temperature on PVs in poultry meat (Table 2) confirm previous findings reported by Sawaya and Abu-Ruwaida (1989). Although spoilage was reached after approximately 6-7, 4-5 and 3-4 d after processing when stored at 4, 7 and 9 °C, respectively, the corresponding PVs were far below the upper acceptable limit of 5 meq/kg meat. This indicates a weak relationship between PV and the degree of spoilage.

Organisms Affecting Sanitation and Public Health

Data obtained on selected organisms of sanitary and public health concern (Table 3) showed high initial counts of coliforms and *E. coli* (average log counts of 4.2 and 2.8 CFU/ml lactose broth rinse, respectively) in fresh carcasses. These high counts indicate contamination or poor sanitation during slaughtering (Jay 1978, Bryan 1980, Tompkin 1983, Wabeck 1987). The levels increased substantially during storage, particularly in carcasses stored at temperatures higher than 4 °C.

Table 3. Organisms of sanitary and public health concern associated with chilled poultry meat during storage at different temperatures

Storage		Mean Bacterial Count (log CFU/ml rinse)				
Temp. °C	**Time (d)**	***S. aureus***	***E. coli***	***Coliforms***	***Campylobacter***	***Salmonella* Positive/Total**
4 °C	0	3.45	2.80	4.20	2.80	8/10
	3	3.10	4.10	4.80	3.60	3/5
	5	3.45	3.70	4.80	4.20	2/5
	8	3.50	5.50	5.80	4.50	4/5
	10	3.70	5.30	6.20	4.30	3/4
7 °C	0	3.45	2.80	4.20	2.80	8/10
	3	3.25	4.20	5.15	3.50	3/5
	5	5.10	5.10	6.10	4.65	3/5
9 °C	0	3.45	2.80	4.20	2.80	8/10
	3	4.40	5.65	6.30	4.30	3/5
	5	6.20	6.10	7.30	ND	3/5

The log counts of *Staph. aures* averaged about 3.4 CFU/ml in the fresh carcases. This level did not increase substantially at storage temperatures of 4 and 7 °C after 8 and 3 d, respectively; however, at 9 °C, the log counts of *Staph. aureus* increased rapidly to 4.4 and 6.2 after 3 and 5 d, respectively. These results agree with those reported by Angelotti *et al.* (1961) and Bryan (1968), who found that this organism can grow in chicken carcasses at temperatures higher than 6-7 °C, but not at temperatures below 5 °C. Although *Staph. aureus* is considered part of poultry's normal flora, high counts are not desirable in food commodities. The high counts are usually associated with production of a heat-resistant enterotoxin that has been held responsible for *Staphylococcus* food-poisoning outbreaks (Tatini 1976, Wieneke and Gilbert 1985, Woolaway *et al* 1986).

Salmonella and *Campylobacter* have been reported in chicken carcasses, and there are epidemiological incidences linking salmonellosis and campylobacteriosis with poultry consumption in many countries (Pivnick 1978, Norberg 1981, Green *et al.* 1982, Tauxe *et al.* 1985, Franco 1988). Chicken carcasses stored at the different temperatures were contaminated with *Campylobacter jejuni.* Initial counts were around log 2.8 CFU/ml, reached 4.5 after 8 d (Table 3). This high occurrence could be due to crosscontamination with the intestinal contents of birds during slaughtering and processing. Similar findings were reported by other investigators, who isolated

Campylobacter jejuni in up to 100% of chicken carcasses tested (Shanker *et al.* 1982, Hartog *et al.* 1983, Munroe *et al.* 1983, Clark and Bueschkens 1988).

On the other hand, 40-80% of chicken carcasses stored at 4, 7 and 9 °C tested positively for *Salmonella,* independent of the storage temperature. This contamination level is relatively higher than the average (up to 71%) in many countries (Barnes 1976, Brayn 1980, Pivnick and Nurmi 1982, Bailey *et al.* 1991). The major serotypes found in this study were *S. ohio, S. enteritidis, S. paratyphi* and *S. krefled.* The same serotypes were isolated from chicken carcasses from the processing plant and retail markets (unpublished work). No *S. typhimurium, S. heidelberg, S. infantis,* which are the most common contaminants of poultry in other countries, were recovered. Such organisms are generally incriminated in food-poisoning attributed to poultry meat in many countries (Sadler and Corstvet 1965, Todd 1980, Pivnick and Nurmi 1982, Kvenberg and Archer 1987, Lammerding *et al.* 1988).

Multivariate hypothesis testing methods were utilized to simultaneously analyze the effects of time and temperature on each of the dependent variable shown in Tables 1 (Sensory and organoleptic properties), 2 (Spoilage indicators) and 3 (Organisms public health concern). The results from each of these multivariate tests are summarized in Table 4. Since the p values for all three experiments are less than 0.05 it can be concluded that the effects of time and temperature were both statistically significant in the sensory, spoilage and microbial organisms experiments.

Table 4. Multivariate hypothesis test for sensory organoleptic properties, spoilage indicators and organisms of sanitary and public health concern

Experimental Data	Wilks' Lambda	F	Num DF	Dem DF	p Value
Sensory organoleptic	0.10316	14.8794	6	42	0.0001
Spoilage Indicators	0.03212	18.3198	8	32	0.0001
Organisms Public Health	0.00537	7.5859	10	6	0.0110

* Wilks' Lambda - see Morrison.

F - Calculated value of the F statistic.

Dem DF - Denominator degrees of freedom.

Num DF - Probability level associated with the calculated F.

The findings of this study on spoilage organisms and others affecting sanitation and public health are important for both the local poultry industry and the consumer. Data indicate that the poultry industry should improve quality control, sanitation and safety measures to reduce spoilage and contamination by *E. coli* and *Coliform* bacteria, *Staph. aureus, Salmonella* and *Campylobacter.* Improvements should start on the farm and continue during slaughtering, processing, transport and storage. The consumer also risks infection by *Salmonella, Campylobacter* and other pathogens by consuming undercooked poultry, or improperly handled poultry products, or through cross-contamination of other foods.

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مدة الصلاحية والنوعية الجرثومية للدجاج الطازج المبرد في دولة الكويت

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تمت دراسة درجات الحرارة في برادات العرض داخل ٤٢ مركز تسويق في الكويت ، وذلك لتحديد مدة صلاحية الدجاج المبرد المطروح في الأسواق المحلية . كما تم قياس تقلبات درجة الحرارة في ١٥ مركز تسويق آخر . وقد أظهرت النتائج أن درجات حرارة التخزين في أكثر من ٥٠٪ من الأسواق التي شملتها الدراسة كانت مرتفعة ، بمتوسط تراوح ما بين ٨-١٠ درجات ، بينما تراوحت تقلبات درجات الحرارة في برادات العرض ما بين ١-٦ درجات مئوية . وتظهر البيانات التي جمعت حول الدجاج المخزن تحت ظروف تخزين تسويقية بأن معدل تلف اللحوم ارتبط مباشرة بدرجة حرارة ومدة التخزين .

وبلغت مدة الصلاحية بعد تصنيع ومعالجة الدجاج المبرد ٧ و ٥ و ٤ أيام عند التخزين تحت درجة حرارة بلغت ٤ و ٧ و ٩ درجة مئوية على التوالي . وقد لوحظ التلف المبكر أول ما لوحظ عندما زاد التعداد اللوغاريتمي الجرثومي عن ٧,٢ مستعمرة/ ملل ، وصاحب ذلك تغيرات في الخواص الحسية للدجاج (كرداءة المظهر ، وبهتان اللون ، وتشكل العفن اللزج ، واختلاف

اللون) ، وازدياد قيم اجمالي مركبات النيتروجين المتطايرة ، والأحماض الدهنية الحرة ، وكذلك انخفاض قيم حجم المستخلص المتحرر .

وأظهرت البيانات أيضاً ارتفاع التعداد الأولي لمستعمرات الـ *E.coli* والـ *coliforms* مما يشير إلى رداءة الظروف الصحية عند ذبح الدجاج . كذلك أظهرت ٦٠-٨٠٪ من العينات وجود كائنات حية دقيقة مسببة للتسمم الغذائي ، كالسالمونيلا ، في حين ظهرت جرثومة الـ *Campylobacter* في جميع العينات . وكان التعداد اللوغاريتمي الأولي للـ *Staphylococcus aureus* يساوي ٤ ,٣ مستعمرة/ ملل . هذا ولم تحدث زيادة تذكر خلال فترة التخزين عند درجة حرارة ٤-٧ ، في حين كانت الزيادة ملحوظة بعد ثلاثة أيام من التخزين تحت درجة حرارة تساوي ٩ درجة مئوية ، إذ كانت الزيادة سريعة وفاقت الـ ٤ ,٧ مستعمرة/ ملل .

أهم المصطلحات : لحوم الدواجن - تلف اللحوم - العوامل المسببة للمرض - البكتريا المحبة للبرودة .

* إلى من توجه له المراسلات .