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BACTERIAL BEHAVIOUR OF SOME MEAT PRODUCTS STORED IN HOME FRIDGE

(With 3 Tables and 3 Figures)

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سلوك الميكروبات في بعض منتجات اللحوم المحفوظة في ثلاجة المنزل

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تم تجهيز ١٥ شيبولاتا بقري ، دواجن وسجق بارد تحت نفس الظروف في أحد مصانع اللحوم بالقاهرة حيث حفظت في ثلاجة المنزل . تم فحص منتجات اللحوم المجهزة بكتريولوجيا لتحديد أعداد الميكروبات الهوائية ، الأنتيروبكترياسي ، المكور العنقودي الذهبي وكذلك الكشف عن تواجد الأيشاريشيا كولاي ، السالمونيلا والشيجيلا بعد الإنتهاء من التجهيز مباشرة (وقت صفر) ثم كل يومين حتى اليوم الرابع عشر من التخزين. في الشيبولاتا البقري تراوح متوسط عدد الميكروبات الهوائية من 10^3 عند بداية التجربة إلـــى 2×10^5/جم عند اليوم الرابع عشر ، بينما تراوح هذا العدد في شيبولاتا الدواجن من 10^2 إلى 2×10^5/جم وفي السجق البارد من 10^3 إلى 4×10^5/جم. لم يستدل على وجود إختلافات في متوسط عدد الأنتيروبكترياسي في الشيبولاتا البقري والسجق البارد ، بينما في شيبولاتا الدواجن أختلف العدد من 10^3 إلى 2×10^3/جم. بالنسبة للمكور العنقودي الذهبي فقد ظل عدده أقل من ٥٠/جم بلا تغيير طوال فترة التخزين. لم يستدل على وجود السالمونيلا والشيجيلا في منتجات اللحوم التي تم فحصها ، ولقد تم مناقشة التوصيات اللازمة لحماية المستهلك.

SUMMARY

Fifteen of beef-, chicken – Chipolata and cold cut sausages prepared under the same conditions in a meat factory in Cairo were stored in home fridge and examined bacteriologically for total aerobic, Enterobacteriaceae, S. aureus counts, detection of the food pathogens E. coli, Salmonella and Shigella at 0 time and every two days till the 14^{th} day of storage. In beef chipolata the mean aerobic count ranged from 10^3 at 0 time to 3×10^4 cfu/gm at the 14^{th} day while in chicken ones ranged from 10^3 till 2×10^5 cfu/gm and from 10^3 to 4×10^5 cfu/gm in cold cut sausages. There is no variations in the mean count of Enterobacteriaceae

in beef chipolata and cold cut sausage while in chicken chipolata it varies from $<10^2$ to $2x10^3$ cfu/gm. S. aureus count remained during the whole storage period 14 days <50 cfu/gm unvariable. No food pathogens, Salmonella or Shigella could be detected. Recommendations to safeguard the consumer were mentioned.

Key words: Bacterial behaviour, meat products.

INTRODUCTION

Over the thousands of years of human history only the past two or three generations have been able to capitalize on recently discovered scientific principles in food preservation, fermentation, and food safety. Temperature manipulation and control rank among the more critical factors are needed to achieve a safe and wholesome food supply.

Chilling temperatures are those close to but above the freezing point of fresh foods, usually -1°C to +7°C. The effect of chilling on the microflora in sausages will depend on the temperature characteristics of the organisms. The rate of growth is sensitive to changes in temperatures below the optimum, growth becomes slower and in the lower ranges (below 0°C) eventually stops.

Meat products are unusually diverse, ranging from those consisting wholly of meat (salami) through those with admixtures of nonmeat protein (casein) or of carbohydrate (sausage rusk) to those in which the meat is only a minor element e.g. certain kinds of meat pie.

Middly heated (pasteurized), cured meats are either heated in final container e.g. sausages in casings or those that are manipulated after heating e.g. portioning, slicing or skinning frankfurters. Those in the last category are frequently repacked prior to sale. Both must be stored under refrigeration.

Products handled after heat treatment will be contaminated with a flora that grows well despite the salt and nitrite, increasing about tenfold per week at 5°C and one-hundred fold at 10°C. The pathogen of most concern in pasteurized cured meats is S. aureus. It rarely survives a proper heat treatment but is frequently a contaminant from the hands of persons who handle and package the meats after processing. Its growth is not controlled by the usual concentrations of salt and nitrite and enterotoxin forms at temperatures suitable for its aerobic multiplications.

The cooling of mesophilic bacteria from the normal growth temperature to about 0°C may result in the death or injury of a proportion of bacteria. Gram-negative bacteria appear to be more susceptible to cold than are Gram-positive organisms. S. aureus is resistant to cold shock.

Abd Almenom (1986) found that the total bacterial count of chilled meat stored at 2-3°C with relative humidity 85% at time 0 was 2 x 10^6. After five days storage the count decreased to 10^5 which reached $6x10^4$ after 10 days storage whereas on the 14th day the count was 9 x 10^4. The Staph. count was 4 x 10^4/g on 0 time and 3 x 10^4 on the 5th day and 3 x 10^4 on the tenth and 7 x 10^4 on the 14th day of storage. He stated that meat became spoiled at 9 x 10^5/gm for aerobic plate count and 2 x 10^5 /gm for Staph. count.

In 1965 Malakhov stated that meat with initial count of 10^2 /cm^2 stored at 10°C formed slime in about 6 days while when kept at 0°C the time was about 15 days. But when meat having 10^5 /cm^2 stored at 10°C its keeping quality was less than 5 days. Also at the time of slime formation the minimum bacterial content ranged from 3 x 10^6 to 5 x 10^7 /cm^2. Meat covered with thick film of slime has a bacterial count 10^9 /cm^2.

Bussem (1980) examined samples of fresh meat after storage for 2 days at 15°C or 4 days at 7°C. The total number of bacteria increased to 10^4/gm after storage.

Abdel Aziz (1997) stated that the mean values ±SE of APC, Enterobacteriaceae and S. aureus count for "beef" samples were 7.8 x 10^6 ±3.2 x 10^6, 1.2 x 10^4 ±2.4 x 10^4 and 2.8 x 10^3 ±6 x 10^2 respectively. He stated that there is slight gradual increase in microbial counts during experimental storage time at chilling temperatures.

The aim of the present investigation is to follow the behaviour of bacteria in some meat products stored in home fridge and to determine the organoleptic changes during the forteen days storage in home fridge.

MATERIALS and METHODS

Fifteen samples of heat treated sausages; five samples each from beef chipolata, chicken chipolata and cold cuts sausages each weighing one kg were prepared in a meat factory in Cairo. Samples were sent to the laboratory and kept in home fridge at temperature ranging from 5°C

to 10°C for 14 days and examined bacteriologically at 0 time and every two days.

Chipolata sausages are beef sausages cooked and served whole. A typical recipe might contain seasoned lean meat, a little rusk and ground rice, coriander, paprika, nut meg, cayenne pepper and thyme all packed in sheep casings and made into small links (Sinclair, 1998).

Sample homogenate was prepared following the technique described by APHA (1992) and the following investigations were performed:

Aerobic plate count was determined using standard plate count agar and the drop plate method recommended by Swanson *et al.* (1992). Inoculated plates were incubated at 25°C for 24 hours.

Total Enterobacteriaceae count was determined using violet red bile glucose agar and the drop plate technique adopted by Swanson *et al.* (1992).

Detection of Escherichia coli was made using the technique described by Hitchins *et al.* (1992). Suspected colonies were purified and identified according to Krieg and Holt (1984).

Isolation of salmonellae and shigellae was made using the technique adopted by Flowers *et al.* (1992) by preenrichment in Rappaport Vassiliadis and selective plating on both SS and XLD. Suspected colonies were purified and identified according to Krieg and Holt (1984).

Temperature of the fridge was recorded during the whole storage period.

RESULTS and DISCUSSION

Refrigeration can substantially reduce the rate at which food will deteriorate. Low temperatures slow down the growth of microorganisms and the rate of chemical changes in food. After the discovery of several commercial methods of producing ice in tropical and other hot weather zones the next urgent application of artificial cold was the preservation of meat and fish by cold storage (Forsythe and Hayes, 1998).

From the achieved results presented in tables 1, 2 and 3 and figures 1, 2 and 3 it is evident that the mean total aerobic counts at 0 time were 10^3, 10^3 and 10^3 cfu/gm at temperature 7°C. After two days the temperature was 5°C and the mean count droped to 4×10^2 cfu/gm in beef chipolata but increased to 3×10^5 cfu/gm in chicken chipolata but

remains as it is in cold cut sausage. After 4, 6 and 8 days storage at 8°C the mean count raised again in beef chipolata and drops in chicken chipolata and cold cut ones. On the 10, 12 and 14 days storage the count is raised as the storage temperature is raised to 9 and 10°C.

Concerning enterobacteriaceae, the mean count $<10^2$ cfu/gm which remained as it is in beef chipolata and cold cut sausage inspite the rise of storage temperature to 10°C. On the other hand, the mean count increased from $<10^2$ cfu/gm at 0 time to $2x10^3$ cfu/gm chicken chipolata at the forteenth day – storage temperature 10°C.

S. aureus count was <50 cfu/gm in all samples at 0 time and remained as it is till the end of the experiment. Concerning S. aureus, it can withstand low temperatures and grow at temperatures down to about 7°C (Angelotti *et al.*, 1961) but the lower limit for toxin production is somewhat higher. Enterotoxin has been detected in foods hold at 10°C (Genigeoris *et al.*, 1969 and Tatini, 1973) but toxin production at temperatures below about 20°C is slow. No E. coli, Salmonella or Shigella could be detected at 0 time and during the whole period of the experiment. This could be attributed to the rapid cooling of meat products, which may result in death or injury to the mesophilic bacteria, which are capable for rapid growth at moderate temperature and include nearly all the pathogens and most food spoilage organisms. Rose (1968) and Abd Almenom (1986) stated that Gram-negative bacteria are more susceptible to cold than Gram positive ones. E. coli has a minimum growth temperature 8–10°C other than Enterobacteriaceae (Gill and Newton, 1977; Goepfert, 1976 and ICMSF, 1980). The presence of any level of bacteria in meat products cannot be a measure of sanitary quality but rather than a measure of microbial quality which becomes important in the organoleptic changes occurring in the product (Goepfert, 1976 and Gunderson, 1980).

Beebe *et al.* (1976) found large increases in bacterial counts of packed top sirloin during 7-14 days storage at 5.5°C and during 14-21 days storage at 0°C. They stated also that there is a significant increase in mesophilic count occurred between 7 and 14 days for cuts stored at 5.5°C. In 1987, Adams *et al.* extended the British fresh sausage shelf life at 6°C to more than 20 days. They found that the mean total viable count was $10^{4.8}$ cfu/g, which after chill storage for 14 days, the mean total microbial counts, was $10^{7.4}$ cfu/gm.

The obtained results were in agreement with those recorded by Elmossalami (1958), Boussem (1980) and Abd Almenom (1986) who

stated that the total number of bacteria increased after cold storage at 7°C.

Samaha and Abdelaal (2000) also stated that the microbial counts in chicken muscles significantly increased by increasing the time of storage at 3 ±1°C.

In 2001, Saleh and Abdelaal found that the incidence of psychrotrophic pathogens in sausage chilled at 1-2°C for 6 days was higher than non chilled ones.

To enhance effectiveness of chilling, sausages capable of supporting microbial growth must be cooled rapidly before storage. This is extremely important, especially for cooked or heated foods that are not consumed shortly thereafter. Failure to cool foods rapidly through this range of temperatures (5-50°C) may allow large microbial populations to accumulate in a relatively short time since this temperature embraces the optimum temperature for growth of all pathogens and most food spoilage bacteria.

Control measures to safe guard the consumer must aim to reduce the microbial population before chilling, assure an effective chilling process, prevent subsequent contamination, and avoid fluctuations in storage temperatures.

The small differences in temperature can have a significant effect on the growth and metabolic activity of bacteria and thereby the keeping quality of chilled foods. A reduction in temperatures from 2.8 to -0.3°C doubled the keeping time of haddock (Castell and MacCallum, 1950).

The temperature at which a food is kept for any time is extremely important. Avoid the temperature in the food thermometer danger zone between 4 and 60°C (40 and 140°F) because this is the temperature range in which food poisoning bacteria may grow. Therefore the shorter the time meat products spend between 4 and 60°C, the less are the chances of food poisoning (CSIRO and Afisc, 1993).

Excessive handling of meat products should be avoided because bacteria are always on the bodies. Although fingers were made before forks, suitable utensils should be used to serve food and, of course, everyone handling food should be scrupulous in his personal cleanliness.

REFERENCES

Abd Almenom, K.H. (1986): Microbial association in cool stored beef. M.V.Sc. Cairo Univ.

Abdel Aziz, A.S. (1997): Quality assurance of a new locally produced meat product beef. Vet. Med. J. Giza 45, 345.

Adams, M.R.; T. Baker and C.L. Forest (1987): A note on shelf-life extension of British fresh sausage by vacuum packing. J. Appl. Bact. 63, 227.

APHA (American Public Health Association) (1992): Compendium of Methods for Microbiological Examination Of Food. 3rd Ed. Washington D.C., USA.

Angelotti, R; M.J. Foster and K.H. Lewis (1961): Time-temperature effects on salmonellae and staphylococci in foods. I. Behavior in refrigerated foods. II. Behaviour at warm holding temperatures. Am. J. Public Health 51, 76.

Beebe, S.D.; C. Vanderzant; M.O. Hanna; Z.L. Carpenter and G.C. Smith (1976): Effect of internal temperature and storage temperature on the microbial flora of vacuum packaged beef. J. Milk Food Technol. 39, 600.

Bussem, M. (1980): Ecology of Enterobacteriacceae on slaughterhouse. Fleischwirtschaft 608, 1529.

Castell, C.H. and W.A. MacCallum (1950): The value of temperatures close to freezing on the storage of fish. J. Fish Res. Board Can 8, 111-116.

CSIRO and Afisc (1993): Food Science Australia Handling Food in the Home – a joint venture of CSIRO & Afisc. Australia PO Box 52, North Ryde NSW 1670.

Eimossalami, E. (1958): Do surface bacteria of dressed cattle increase in chilling room?. Vet. Med. J. 5, 113.

Flowers, R.S.; J.Y. D'Aoust, W.H. Anderwa and J.S. Baily (1992): In: Compendium Methods for Microbiological Examination Of Food. (3rd Ed), by C. Vanderzant and D. Sphittoesser (Eds.), pp. 371-422, American Public Health Association Washington DC, USA.

Forsythe, S.J. and P.R. Hayes (1998): Food Hygiene, Microbiology and HACCP. 3rd Ed. – Aspen Publishers, Inc. Gaitherburg, Maryland.

Genigeoris, C.; H. Riemann and W.W. Sadler (1969): Production of enterotoxin B in cured meats. J. Food Sci. 34, 62.

Gill, C.O. and Newton, K.G. (1977): The development of aerobic spoilage flora on meat stored at chill temperatures. J. Appl. Bact. 43, 189.

Goepfert, J.M. (1976): The aerobic plate count, coliforms and E. coli content of raw ground beef at the retail level. J. Milk Food Technol. 39, 195.

Gunderson, M.F. (1980): Microbiological standards for frozen foods. US. Dept. of Agri. Western Utilization Research and Development Division. Albany Aulif

Hitchins, A.D.; P.A. Hartman and E.C. Todd (1992): In: Compendium of Methods for Microbiological Examination Of Food. (3rd Ed), C. Vanderzant and D. Sphittoesser pp. 325-366, American Public Health Association Washington DC, USA.

ICMSF (1978): Microorganisms in foods. 2. Sampling for microbiological analysis. Principles and specific applications. Univ. of Toronto Press, Toronto, Ontario Canada.

ICMSF (1980): Microbial Ecology of Foods. Factors affecting life and death of microorganisms Vol. I, Food Commodities Vol II., Academic Press London.

International organization for Standardization, Technical committee agricultural food products (1977): Sampling and testing methods of meat and meat products Subcomittee- Meat and meat products ISO Memento.

Krieg, M.R. and J.G. Holt (1984): Bergy's Manual of Systemic Bacteriology Vol. 1 Williams and Willkin's Baltimore, London.

Mackey, B.M. (1980): Growth of Salmonella on chilled meat. J. Hyg. Camb. 85, 115.

Malackhov, A. (1965): Microbiology of meat and meat products. Visiting professor – Cairo Univ. Fac. Vet. Med.

Rose, A.H. (1968): Physiology of microorganisms at low temperature. J. Appl. Bact. 31,1.

Saleh, E.A. and B.G. Abdelaal (2001): Incidence and significance of some psychrotrophic pathogens in meat and meat products. Egypt. J. Biomed. Sci. 8, 71.

Samaha, I.A.; B.G. Abdelaal (2000): Microbiological changes in chicken carcases kept at chilling conditions. Egypt. J. Biomed. Sci. 6, 11.

Sinclair, C.G. (1998): International Dictionary of food and cooking. Peter Collin Publishing Ltd. Middle sex, TW11 8DT, England.

Swanson, K.M.J.; F.F. Busta; E.H. Peterson and M.G. Johnson (1992): In: Compendium Methods for Microbiological Examination Of Food. (3rd Ed), C. Vanderzant and D. Sphittoesser, pp. 75-96, American Public Health Association Washington DC, USA.

Tatini, S.R. (1973): Influence of food environments on growth of S. aureus and production of various enterotoxins. J. Milk Food Technol. 36, 559.

Table 1: Mean bacterial counts in *vacuum packed beef chipolata* stored in home fridge.

Microbiological results	Fridge Temp. °C							
	7	5	8	8	8	9	9	10
	Storage / Day							
	0	2	4	6	8	10	12	14
Total aerobic count cfu/g	10^3	$4x10^2$	$4x10^3$	$6x10^3$	$4x10^3$	$8x10^3$	10^4	$3x10^4$
Enterobacteriaccae count	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$
E. coli	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Salmonella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Shigella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Staph. aureus	<50	<50	<50	<50	<50	<50	<50	<50
Total microbiological evaluation	A	A	A	A	A	A	A	A

Neg.= Negative A= Excellent

Table (2): Mean bacterial counts in *vacuum packed chicken chipolata* stored in home fridge.

Microbiological results	Fridge Temp. °C							
	7	5	8	8	8	9	9	10
	Storage / Day							
	0	2	4	6	8	10	12	14
Total aerobic count cfu/g	10^3	$3x10^5$	$4x10^4$	$4x10^5$	$4x10^3$	$5x10^3$	10^5	$2x10^5$
Enterobacteriaceae count	$<10^2$	$2x10^3$	$3x10^2$	$8x10^2$	$4x10^2$	$6x10^2$	10^2	10^3
E. coli	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Salmonella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Shigella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Staph. aureus	<50	<50	<50	<50	<50	<50	<50	<50
Total microbiological evaluation	A	A	A	A	A	A	A	B

Neg.= Negative A= Excellent B= Satisfactory

Table 3: Mean bacterial counts in *cold cuts sausage* stored in home fridge.

Microbiological results	Fridge Temp. °C							
	7	5	8	8	8	9	9	10
	Storage / Day							
	0	2	4	6	8	10	12	14
Total aerobic count cfu/g	10^2	10^2	$2x10^2$	$8x10^2$	$8x10^2$	10^3	$3x10^5$	$4x10^5$
Enterobacteriaceae count	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$	$<10^2$
E. coli	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Salmonella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Shigella	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Staph. aureus	<50	<50	<50	<50	<50	<50	<50	<50
Total microbiological evaluation	A	A	A	A	A	A	B	B

Neg.= Negative A= Excellent B= Satisfactory

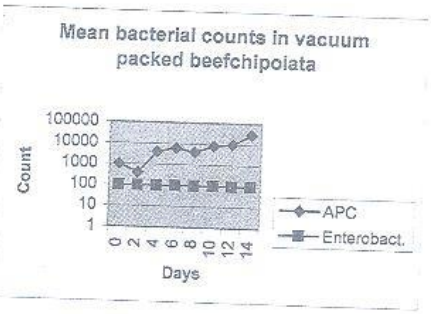

Fig. 1

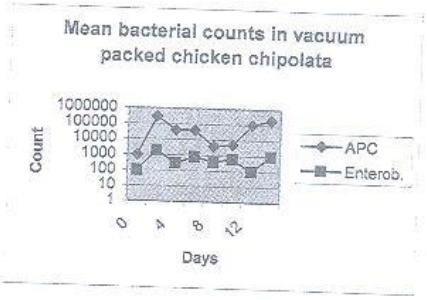

Fig. 2

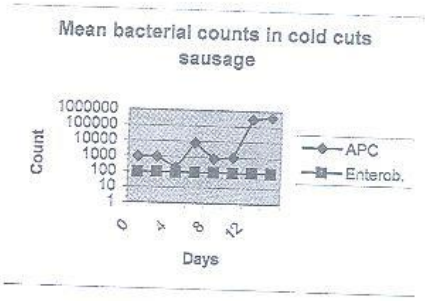

Fig. 3