Bakteriologische Zusammenhänge in rohem und verarbeitetem Fleisch und ähnlichen Produkten

J.F. DEMPSTER

An Foras Taluntais, Dunsinea Research Centre, Castleknock, County Dublin, Irland

Zusammenfassung

Ergebnis einer Vergleichsstudie durch Ermittlung der Bakteriengesamtzahl und der Anwesenheit von Esch. coli und Salmonellen spp. in Fleisch und ähnlichen Produkten.

Einhundertfunfzehn Muster wurden von einer ortlichen Fabrik gesammelt, im Zeitraum 1976/1977. Die Informationen wurden analysiert um herauszufinden ob zwischen der Gesamtzahl der Bakterien und den Krankheitstragern irgendein Zusammenhang besteht.

In der Hauptzahl der Falle war keine Wechselbeziehung zwischen der Gesamtzahl und Esch. coli festzustellen. Bedeutende negative Wechselbeziehungen existierten jedoch fur Steakburger ($P < 0.05$), Frankfurter Wurstchen ($P < 0.01$), und Fruhstucksfleisch ($P < 0.05$) was darauf hindeutet dass bei steigender Gesamtzahl die Zahl der Esch. coli abnahm.

Sieben Prozent der Proben waren Salmonella-positiv. Die durchschnittszahlung Esch. coli von der letzteren ($\log_{10}$ 4.51 g^{-1}) war bedentend hoher ($P < 0.01$) als die duchschittszahlung Esch. coli bei den Salmonella-negativ proben ($\log_{10}$ 2.89 g^{-1}). Dass lasst darauf shliessen dass die Proben mit hoher Esch. coli zahlungen sind mit grosserer wahrschinlichkeit Salmonella-positiv als die proben with einer niedrigen anzahl von Esch. coli.

Bacteriological relationships in raw and processed meats and associated products

J.F. DEMPSTER

An Foras Taluntais, Dunsinea Research Centre, Castleknock, County Dublin, Ireland.

Abstract

A study was made to collate information on the total plate count and the presence of Esch. coli and Salmonella spp. in meats and associated products.

One hundred fifteen samples were collected from a local factory during 1976/1977. The data were analysed to establish if any relationship existed between total bacterial numbers and pathogens.

No significant correlation existed between total numbers and Esch. coli in the majority of cases. However, significant negative correlations existed for steak-burgers ($P < 0.05$), frankfurters ($P < 0.01$) and luncheon roll ($P < 0.05$) indicating that as total numbers increased, numbers of Esch. coli decreased.

Seven percent of the samples were Salmonella-positive. The mean Esch. coli count of the latter ($\log_{10}$ 4.51/g) was significantly higher ($P < 0.01$) than the mean Esch. coli count of the Salmonella-negative samples ($\log_{10}$ 2.89/g). This implies that samples with high Esch. coli counts are more likely to be Salmonella-positive than samples with low numbers of Esch. coli.

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Rapports bactériologiques dans les viande crues, viandes de conserve et produits associés

J.F. DEMPSTER

An Foras Taluntais, Dunsinea Research Centre, Castleknock, County Dublin, Irlande.

Résumé

Une étude a été menée, visant à comparer des informations sur le dénombrement total de colonies et la presence d'Esch. coli et de Salmonellae spp. dans les viandes et produits associés.

115 échantillons ont été prélevés d'une usine locale durant les années 1976 et 1977. Les données ont été analysées afin d'établir l'existence de rapports entre le dénombrement bactérier total et des pathogènes. Aucune correlation significative existait entre les dénombrements totaux et d'Esch. coli dans la majorité des cas. Cependant, une corrélation négative significative existait pour les steakburgers ($P < 0.05$), saucisses de Francfort ($P < 0.01$), saucisses 'luncheon-rolls' ($P < 0.01$) indiquant une diminution des nombres d'Esch. coli inversement proportionelle a l'accroissement des dénombrements totaux.

Sept pour cent des échantillons étaient salmonella positifs. Le moyen compte d'Esch. coli de la dernier ($\log_{10}$ 4,51 g^{-1}) etait significativement plus haut ($P < 0.01$) que le moyen compte d'Esch. coli des salmonella-negatif échantillons ($\log_{10}$ 2.89 g^{-1}). D'ici, les échanillons avec hauts comptes d'Esch. coli auront plus de possibilite d'être salmonella-positif que les échantillons avec les bas comptes d'Esch. coli.

Бактериологические соотношения в сырой и переработанной мясе и сопутствующих продуктах.

Дж. Ф. Демпстер

An Foras Taluntais, Dunsinea Research Centre, Касельнок Графство Дублин, Ирландия.

Резюме.

Исследование сделано для сравнения сведений о суммарном числе бактерий и о присутствии Esch. coli и Salmonella spp. в мясе и сопутствующих продуктах.

В течение 1976/1977 года из местного завода собрали 115 образчиков. Данные были анализированы чтобы установить любые соотношения существующие между общим числом бактерий и палочками.

В большинстве случаев не было значительной корреляции между суммарным числом бактерий и Esch. coli. Всё-таки значительная отрицательная корреляция существовала для рубленой котлеты (steak-burgers) ($P < 0.05$), сосиск (frankfurters) ($P < 0.01$) и мясного рулета (luncheon roll) ($P < 0.05$) указывая что так как общее число увеличилось, число Esch. coli уменьшилось. Семь процентов образчиков были Salmonella-положительные. Среднее число Esch. coli последних ($\log_{10}$ 4,51 g^{-1}) было значительно выше ($P < 0.01$) среднего числа Esch. coli для Salmonella-отрицательных образчиков. Выводится заключение что образчики с высоким числом Esch. coli могут быть более вероятно Salmonella-положительные чем образчики с низким числом Esch. coli.

Bacteriological relationships in raw and processed meats and associated products

J.F. DEMPSTER

An Foras Taluntais, Dunsinea Research Centre, Castleknock, County Dublin, Ireland.

Introduction

Among the most popular 'indicator' tests used to determine the bacteriological quality of a food are the total aerobic plate count, 'coliform' count and Esch. coli count (Miskimin et al 1976). However, a clear distinction has been made between bacteriological quality of food and safety of food by Read and Baer (1974) who stated that standards for quality and safety are quite separate as are the tests for them. Thus the presence of coliforms or large numbers of bacteria in meat have a much different meaning than they would have, for example, in water and milk (Goepfert, 1976) where a single test (Esch. coli) assesses both 'cleanliness' or quality and safety in water (Kitchell, 1967). The presence of Esch. coli in meat does not indicate there are pathogens present. A search of the literature by Goepfert, (1976) failed to reveal any published data of a correlation between Esch. coli and salmonella organisms in raw beef and Hagberg et al (1973) noted no such relationship in turkey processing plants. According to Roberts (1976) there is no constant ratio of Esch. coli or coliforms or Enterobacteriaceae to salmonella and salmonella organisms may be found on clean or dirty carcass meat.

However, Tompkin and Kueper (1973) observed that the rate of 'salmonella' isolations increased in rendered animal by-products from 12% to 70% as the aerobic plate count increased from $<10^4$/g to 10^7/g . Furthermore, when the aerobic count of barbacued chicken was $<10^4$/g enterococci, among other 'indicator' organisms, were absent, but when the plate count increased to 10^4, 10^5 and 10^6/g , pathogens were observed in 5%, 9% and 39% of chickens respectively, Seligman and Frank-Blum, 1974.

This study was therefore undertaken to collate information on the total aerobic plate count and the presence of pathogens (Esch. coli I and Salmonella spp.) in raw and cooked meats and associated products and to establish if any relationship existed between them.

Materials and Methods

(a) Samples.

Seventy-one samples (group 1) were collected from a local factory between May - September 1976. They were transported to the laboratory in plastic pouches within 1 hr and held at +4°C before examination. Of the 71, 20 had received some form of heat treatment. To increase the number of samples for statistical analysis, a further 44 (group 2) were collected between February - May 1977 in the same manner. None of these had received a heat treatment. They were frozen (-18°C) and were between 16 and 22 days old when examined, Table 1.

(b) Total aerobic count

Ten gram aliquots of each sample (group 1) were weighed and transferred to 100 ml Ringers diluent +0.1% of added peptone in a plastic pouch. The sample was homogenised for 60 sec. in a Colworth Stomacher 400 (A.J. Seward, Bury St. Edmunds, Suffolk, England). Serial decimal dilutions were made and plated in duplicate using a 1 ml 'Oxford' sampler pipette with a disposal tip by the method of Bousfield, Smith and Trueman (1973). Pre-dried plates of Oxoid Plate Count Agar (PCA) were divided into quarters and inoculated with replicate 0.025 ml amounts using a 25 ul 'Oxford' sampler. Incubation was at 25°C for 3 days. Where cured products were examined, 4% (w/v) of added salt (NaCl) was used in the count medium.

(c) Escherichia coli

This was estimated by membrane filtration. One millilitre of the homogenate described above was serially diluted and filtered by the method described by Dempster et al (1973). Confirmation of type I Esch. coli was obtained by growing typical lactose-fermenting colonies in peptone water and MacConkey broth (18h/44°C) since indole production in the former and acid+gas in the latter are indicative of Esch. coli faecal type I (Howe and Linton 1976).

(d) Salmonella

Fifty grams of sample were weighed and aseptically combined with 100 ml Ringer's diluent + 0.1% peptone in a plastic pouch and homogenised as described above. One hundred millilitres of double strength Mannitol Selenite broth (Oxoid C m 39a) were added, thoroughly mixed and the total volume (200 ml) of single strength broth transferred to a sterile screw capped jar. Incubation was for 48h at 41°C. Another 50g sample was similarly homogenised in Ringer's diluent and 100 ml double strength tetrathionate broth (CM 29) added and transferred to a similar jar for incubation at 37°C for 48h. A loopful of culture from each bottle was streaked after incubation on to Brilliant Green Agar plates (Oxoid CM 263) and the plates incubated at 37°C for 24h. Suspect colonies were picked into lysine decarboxylase medium (Moeller 1955) and streaked on to freshly poured PCA plates (Oxoid) for biochemical and serological recognition of salmonellae by the procedure of Georgala and Boothroyd (1969).

Group 2 samples were thawed for 24h at room temperature (C.18°C) and examined for total numbers, Esch. coli and salmonella in the same fashion as Group 1 samples.

(e) Statistical analysis

The correlations between total count and Esch. coli count were calculated for each set of data and for all the

data. The mean Esch. coli count was calculated for samples with salmonella present and for samples with salmonella absent.

Results and Discussion

Group I samples

Of 71 products, 24 (34%) contained less than 20 Esch. coli/g and 13 (18%) less than 1×10^6/g (total aerobic count). Only 4 (5.6%) samples were salmonella-positive, these were chicken/ham mix (2), pork sausage (1) and pork streak (1) Table 2.

Six out of 8 samples of luncheon roll (75%) and 9/20 (45%) pork sausage samples had less than 20 Esch. coli/g, whereas 4/6 (66%) chicken/ham; 4/4 (100%) pork skin, 7/20 (35%) pork sausage and 4/5 (80%) samples of raw beef contained more than 1,000 Esch. coli/g , despite the fact that some of these products had been heat-treated. Possibly this high incidence was a result of improper handling post-heating, inadequate storage or in the case of unheated samples, to a carry-over contamination effect from the slaughter hall.

Only one sample (pork streak) exhibited organoleptic spoilage at examination, i.e., it had an off-odour and the meat was discoloured. Characteristically, the total aerobic count was 47×10^{10}/g. Perhaps surprisingly it contained only 10 Esch. coli/g and it was salmonella-negative despite the generally held opinion that a high total viable count in a food is indicative of a greater risk of pathogens being present (Miskimin et al, 1976). One other 'pork streak' was salmonella-positive (Salm. panama) and had an Esch. coli count of 90/g and a total count of 182×10^4/g. The remaining four samples of pork streak were salmonella-negative and had total counts ranging from 192×10^2 to 52×10^8/g and Esch. coli counts ranging from 30 to 1,300/g respectively. Obviously, there was no uniform pattern in these results and although Roberts (1976) was referring to carcass meat when he stated ... 'there is no constant ratio of Esch. coli or coliforms or Enterobacteriaceae to salmonella organisms', the same statement could be made of the present samples. Furthermore, the use of total counts has been criticised by Elliott and Michener (1961) who said that the assumption by many that low total count indicates safety has been shown to be not always true. Furthermore, the multiplicity of factors involved makes generalisations on the value of total counts virtually impossible according to Silliker (1962). In fact, many workers have stated that total numbers of organisms are unrelated to the presence or absence of pathogens. The above opinion of Elliott and Michener was also held by Hobbs and Wilson (1959) who found Salmonella spp. on meats where there were low counts and no 'faecal' organisms. Therefore, high numbers of viable aerobes do not necessarily indicate a potential hazard from pathogenic bacteria nor do they reflect poor hygienic conditions.

In the majority of cases, no correlation existed between total viable count and Esch. coli count (Table 3). In only two cases was there a negative correlation (steakburgers $P < 0.05$ and frankfurters $P < 0.01$) indicating that as the total count increased, so the Esch. coli count decreased. The correlation was non-significant ($R = 0.13$) when the data were pooled.

Table 1. Type and number of products examined and heat treatments applied

Group 1 (Held 1 hr/4°C before testing)

Product	n	Heat Treatment
Chicken/Ham mix	6	-
Pork sausage	20	-
Steakburger	7	-
Raw beef	5	-
Pork lean[1]	4	-
Pork skin	4	Cooked at 185°F until pliable, then passed through colloid mill and filled into shallow trays for storage at 4°C
Plasma[2]	3	-
Luncheon roll	8	2½ hr/165°F
Pork streak[3]	6	-
Frankfurter	5	2½ hr/165° + 30 min/165°F
White pudding	3	45 min/196°F
Total	71	

Group 2 (Held 16 - 22 days/-18°C before testing)

Chicken/Ham mix	5	-
Chicken/Ham mix	17	-
Chicken/Ham mix	11	-
Luncheon roll	11	-
Total	44	

1 = Shoulder meat

2 = Equal amounts of lard + ear scalps + 40 g water + 40 kg dehydrated blood.

3 = Cut from pork carcass 2 days post-mortem

Table 2. Total aerobic count and specific pathogens in pork, beef and associated products (Group 1 samples)

Sample	n	Total count g^{-1}				Esch. coli 1 g^{-1}				Salmonella
		$<10^6$	$>10^6$ $<10^7$	$>10^7$	$>10^8$	<20	20-10^2	$>10^2$	$>10^3$	
Chicken/Ham mix	6	-	2	3	1	2	-	-	4	Salm. newport (2)
Pork sausage	20	3	2	6	9	9	-	4	7	Salm. newport (1)
Steakburger	7	-	-	4	3	3	-	2	2	
Raw beef	5	1	-	1	3	1	-	-	4	
Pork lean	4	1	1	1	1	-	2	1	1	
Pork skin	4	-	2	2	-	-	-	-	4	
Plasma	3	1	1	1	-	-	-	2	1	
Luncheon roll	8	3	1	3	1	6	-	-	2	
Pork streak	6	2	1	-	3*	1**	2	2	1	Salm. panama (1)
Frankfurter	5	1	-	1	3	2	1	1	1	
White pudding	3	1	1	-	1	-	-	1	2	
Total	71	13	11	22	25	24	5	13	29	4
% Total	100	18.3	15.5	31.0	35.2	33.8	7.0	18.3	40.8	5.6

* One sample had 47×10^{10} g^{-1} total count

** 10 Esch. coli g^{-1}

Table 3. Correlation between Esch. coli count and total aerobic count ($\log_{10}$ g^{-1}) of 71 samples (Group 1)

Sample	n	Correlation coefficient	Significance level
Chicken/Ham mix	6	-0.66	N.S.
Pork sausage	20	0.43	N.S.
Steakburger	7	-0.78	5%
Raw beef	5	0.73	N.S.
Pork lean	4	0.82	N.S.
Pork skin	4	0.65	N.S.
Plasma	3	0.23	N.S.
Luncheon roll	8	0.55	N.S.
Pork streak	6	-0.28	N.S.
Frankfurter	5	-0.96	1%
White pudding	3	0.76	N.S.
All data	71	0.13	N.S.

Group 2 sample

Of the 44 examined in March - May 1977, all exceeded 10^7/g total count and of these 26 (59%) even exceeded 10^8/g. Only 4 (9%) had an Esch. coli count of less than 10^3/g; the remainder exceeded 10^3/g, Table 4. These samples were aged when examined; they had been stored at -18°C for upwards of 3 weeks before being tested. Ninety-one percent contained $>10^3$/g Esch. coli after freezing. These meats therefore must initially have had much higher numbers of faecal coliforms because Esch. coli rapidly dies out at freezer temperature, (Berry 1946). Four of the samples (9%) were salmonella-positive (Table 4). As before, no correlation was found between total count and Esch. coli count except for one set of samples (luncheon roll) where a negative correlation was again obtained ($P < 0.05$). The correlation was non-significant ($R = 0.05$) when the data were pooled, Table 5.

For both groups 1 and 2, the mean Esch. coli count ($\log_{10}$ 4.51/g) for the eight salmonella-positive samples was significantly higher ($P < 0.01$) than the mean Esch. coli count ($\log_{10}$ 2.89/g) for the salmonella-negative samples. This implies that these meat samples with high Esch. coli counts ($>\log_{10}$ 3.0/g) are more likely to be salmonella-positive than samples with low Esch. coli counts ($<\log_{10}$ 3.0/g)

Table 4 Total aerobic count and specific pathogens in processed meats (Group 2 samples)

Sample	n	Total Count g^{-1}				Esch. coli 1 g^{-1}				Salmonella
		$<10^6$	$>10^6$ $<10^7$	$>10^7$	$>10^8$	<20	20 - 10^2	$>10^2$	$>10^3$	
Chicken/Ham mix	5	-	-	1	4	-	-	-	5	Salm. typhimurium (1)
Chicken/Ham mix	17	-	-	6	11	-	-	-	17	Salm. derby(2)
Chicken/Ham mix	11	-	-	6	5	-	-	-	11	Salm. typhimurium (1)
Luncheon roll	11	-	-	5	6	-	-	4	7	-
Total	44	-	-	18	26	-	-	4	40	4
% Total	100	-	-	41.0	59.0			9.1	90.9	9.0

Table 5. Correlation between Esch. coli count and total aerobic count (log_{10} g^{-1}) of 44 samples (Group 2)

Sample	n	Correlation coefficient	Significance level
Chicken/Ham mix	5	-0.08	N.S.
Chicken/Ham mix	17	0.17	N.S.
Chicken/Ham mix	11	0.37	N.S.
Luncheon roll	11	-0.61	5%
All data	44	0.05	N.S.

Acknowledgements

I wish to thank Mrs Carmel Wills and Miss Geraldine Curtin for technical assistance; Mr John Sherington for statistical analysis and the laboratory staff of Donnelly (Dublin) Ltd. for the collection and storage of samples.

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