Die Bakteriologie der Pökellaken von Vielnadel-Injektoren

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Es wurde angestellt eine Untersuchung zur Abschätzung des bakteriellen Zustandes der in Vielnadel-Pökelinjektoren verwendeten Pökellaken, wo die überschüssige Lake rezirkuliert, jedoch ausser Grobfiltration unbehandelt wurde. Die Laken wurden zur Pökelung von Schweinefleischstücken und Hälften bei der Herstellung von Speck verwendet. Es wurde bestimmt während eines Zeitraums von 3 Jahren die Gesamtkolonieanzahl sowie der Gehalt an halophilischen Vibrio, azidurischen Milchsäurebakterien und Enterokokken von aus 9 verschiedenen Betrieben stammenden Proben.

Trotz erheblicher Schwankungen zwischen verschiedenen Betrieben erwirkt die Rezirkulation eine wesentliche Vermehrung des Keimgehalts der Lake, welcher einige mit dem Verderben verschiedener Pökelwaren bekanntlich verbundenen Keimarten einschliesst. Die Analyse der rezirkulierten Laken zeigte, dass die auf frischen Schweinekörpern normalerweise gefundenen Keimarten (Micrococcus, Acinetobacter, Flavobacterium und koryneforme Bakterien) die vorherrschende Flora bildeten; dies bestätigt also, dass der Fleisch selbst die hauptsächliche Quelle der Verunreinigung darstellt.

Erst als die Bedeutung der Verwendung von höchst kontaminierten Laken zur Fleischpökelung festgestellt worden ist, wird es möglich sein, mikrobiologische Massstäbe zur Verwendung bei der Qualitätskontrolle festzulegen.

The bacteriology of bacon curing brines from multi-needle injection machines

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A survey was conducted to assess the bacteriological status of curing brines used in multi-needle injectors, where surplus brine was recirculated but untreated other than a coarse filtration. The brines were used for curing cuts and whole sides of pork for bacon. Samples were examined from 9 different factories over a 3 year period for total colony count and counts of halophilic Vibrio, aciduric lactic acid bacteria and enterococci.

Despite wide variations between factories, the practice of recirculation markedly increases the bacteriological load of the brine, which includes species known to be associated with spoilage of different cured products. Flora analyses of recirculated brines showed a predominance of species normally found on fresh pork carcases (Micrococcus, Acinetobacter, Flavobacterium and coryneform bacteria), thus confirming that the meat itself is the major source of the contamination.

Microbiological standards for use in quality control cannot be formulated, until the significance of using highly contaminated brine in meat curing has been established.

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La bactériologie des saumures de salaison des injecteurs à plusieurs aiguilles

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Une étude a été abordée pour estimer l'état bactériologique des saumures de salaison employées dans les injecteurs à plusieurs aiguilles, où le surplus de saumure a été recirculé, pourtant sans être soumis à aucun traitement sauf la grosse filtration. Les saumures étaient utilisées pour la salaison des morceaux et des demi-carcasses de porc pour le bacon. On a examiné pendant une période de 3 ans des échantillons provenant de 9 usines différentes, pour déterminer le dénombrement total des colonies bactériennes, ainsi que des Vibrio halophiles, bactéries d'acide lactique aciduriques et enterocoques.

Malgré de grandes variations entre les différentes usines, la recirculation augmente sensiblement la teneur en germes de la saumure, qui comprend des espèces reconnues comme étant associées avec la putréfaction des produits salés. L'analyse de la flore des saumures recirculées a mis en évidence la prédominance des espèces normalement rencontrées sur les carcasses de porc fraîches (Micrococcus, Acinetobacter, Flavobacterium et bactéries coryneformes), ce qui confirme que la viande même représente la source principale de la contamination.

Des normes microbiologiques pour l'emploi dans le contrôle de qualité ne peuvent être formulées, jusqu'à ce que la significance de l'utilisation d'une saumure fort contaminée pour la salaison de la viande ait été établie.

The bacteriology of bacon curing brines from multi-needle injection machines

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In recent years there has been an increase in the use of multi-needle brine injection machines for the curing of boneless pork, and some of these have now been adapted to inject whole sides of pork for Wiltshire style bacon. There are a number of types of machine available, but all have a similar mode of operation.

From a reservoir in the machine brine is pumped through a series of needles into meat, which passes along a moving belt. Normally there are 2-3 rows of needles spaced at 1 inch intervals. The brine pressure/volume and belt speed can be adjusted, so that the percentage of brine injected into the meat can be readily controlled. Surplus brine from the needles and from the meat passes through a series of filters, to remove gross meat particles, and is returned to the reservoir. The main advantages of this method of brine injection are the uniform distribution of curing salts to all parts of the musculature, a reduction in the maturation time, and accurate control of the injected brine.

Multi-needle brine injectors (MNI) are traditionally used for boneless meat, which will be further processed (e.g. cooked), and boneless joints to be sliced and vacuum packed. It is only in the last few years that Wiltshire style bacon has been produced in this manner.

There are no reports in the literature on the bacteriology of the curing brines used in MNI machines. The work reported in this paper was designed to assess total colony counts and levels of potential spoilage bacteria in such brines with particular regard to brines which were recirculated during production.

Materials and Methods

Brines. Fresh (499) and recirculated (501) curing brines were examined from 9 factories over a 3 year period. Samples of fresh brine were taken from storage tanks or directly from the MNI before the start of production and samples of recirculated brine from the storage tank of the MNI during production. Samples were taken in disposable plastic jars (Richardsons of Leicester Ltd.) and transported to the laboratory under refrigeration, where they were analysed within 24 hr.

Bacteriological analysis. Serial dilutions of each sample prepared in sterile diluent (% w/v NaCl, 4.0; peptone (Oxoid L37), 0.1) (Gardner & Kitchell, 1973) were plated out by a 'drop and spread' technique on a total count medium with 4% NaCl (TCM4) (Gardner, 1968), a selective medium for halophilic Vibrio (CVKA) (Gardner, 1973a), and medium to enumerate aciduric lactic acid bacteria (AA) (Rogosa, Mitchell & Wiseman, 1951). One ml of brine was added to 9 ml sterile diluent and filtered through a membrane (Oxoid 47 mm diam). For the enumeration of enterococci the membrane was transferred to plates of M. Enterococcus Agar (ME) (Difco). TCM4 plates were incubated at 22° for 5 days; CVKA, 22° for 3 days; AA, 30° for 3 days, and ME, 44° for 2 days, before colonies were enumerated.

Identification of isolates. The selection of colonies from TCM4 plates of 7 recirculated MNI brine samples and the methods of identification have been described earlier (Gardner & Patton, 1969).

Results

Total colony counts of multi-needle injector brines. The results are given in Table 1. The overall average total colony count was 4.61×10^3 for fresh and 48.38×10^3 for recirculated brines. There were differences between brines from different factories, so these averages can only serve as a general guide to the levels of contamination. Analysis of the distribution of the brines in categories, with a 10 fold difference in each, would indicate that the recirculated brines were probably nearer 100 times more heavily contaminated than the fresh.

Total colony counts on fresh brines will reflect the bacteriological quality of the ingredients, i.e. water and curing salts, and the hygienic condition of the equipment involved in preparation and storage. Normal injection brines used for hand pumping are in general of better bacteriological quality (Gardner, 1973b). Counts exceeding 10^3/ml are classified as poor or very poor. Only 64.3% of the fresh brines on this classification could be regarded as good or fair.

Of the recirculated brines 14.2% had total colony counts exceeding 10^5/ml. This additional contamination resulted from the removal of bacteria from the meat being injected by the washing action of the surplus brine. The contribution of this factor will be reflected in the bacteriological condition of such meat, bone dust etc. In addition the bacteriological status of the machine will influence the level of micro-organisms in the brine. The types of bacteria from the TCM4 plates found in recirculated brines are given in Table 2. Those that occur most frequently, Micrococcus, Acinetobacter, Flavobacterium and coryneform bacteria, are common contaminants of fresh pork carcases.

Table 1. Results of bacteriological analyses of 499 samples of fresh and 501 samples of recirculated injection brines from multi-needle injection machines.

	Brine sample	Mean count/ml	Percentage of brines in categories				
			Counts/ml ($x10^3$)				
			<0.1	0.1-1.0	1.1-10.0	10.1-100	101-1000
Total colony count	Fresh	4,610	15.4	48.9	26.7	8.2	0.8
	Recirculated	48,380	0.6	5.2	32.7	47.3	14.2
			Counts/ml				
			<10	10-100	101-1000	1,010-10,000	
Vibrio	Fresh	42.1	90.4	7.4	1.6	0.6	
	Recirculated	489.0	15.2	35.5	33.1	16.2	
Aciduric lactic acid bacteria	Fresh	3.7	92.8	6.2	1.0	0	
	Recirculated	110.0	31.5	46.9	19.4	2.2	
			Counts/ml				
			<1	1-10	11-100	101-1,000	
Enterococci	Fresh	0.22	96.4	3.2	0.4	0	
	Recirculated	18.10	39.7	36.3	18.6	5.4	

Table 2. Results of flora analyses of 7 "recirculated" MNI brines

Genus or group	No. of isolates	% of total	No. of brines (out of 7) where found
Micrococcus	49	33.6	7
Acinetobacter	34	23.3	6
Flavobacterium	19	13.0	7
Coryneform organisms	12	8.2	6
Achromobacter	11	7.5	4
Alcaligenes	7	4.8	2
Pseudomonas	5	3.4	4
Yeasts	4	2.7	3
Vibrio	2	1.4	1
Unidentified	3	2.1	3
TOTAL	146	100.0	

(Mean count on TCM4 at 22° = 65,300/ml)

Vibrio counts of multi-needle injector brines. Halophilic Vibrio are known to cause spoilage of bacons (Gardner & Patton, 1969; Gardner, 1971; Gardner, 1973a,c; Gardner, 1975a). Counts of these bacteria were made to assess the contribution of multi-needle injector brines in the contamination of fresh pork, where they have not been found (Gardner, 1973c). The results are given in Table 1.

Vibrio were relatively rare in fresh brines; 90.4% had <10/ml, the lower counting limit, but occasionally counts exceeded 10^3/ml (0.6% of samples).

However, in 16.2% of recirculated brines Vibrio counts exceeded 10^3/ml. Their presence in injection brine has been demonstrated to originate mainly from the MNI machine. Improper cleaning, particularly of the belts and filtration apparatus, will allow growth of Vibrio on pieces of cured tissue. Experiments (Gardner, unpublished) have shown that when Vibrio-free fresh brine is added to the MNI storage tank and the machine operated without fresh meat, recirculation can result in a rapid (1-2 min) build-up of Vibrio in the brine. This demonstrated that the brine removes bacteria from the meat tissues lodged within the MNI machine. Thus levels of Vibrio in a system where there is little opportunity of the brine of MNI being contaminated from cured meat will reflect the general hygiene of the machine.

Lactic acid bacteria counts of multi-needle injector brines. Aciduric lactic acid bacteria were enumerated on AA (Rogosa, Mitchell & Wiseman, 1951), a medium known to allow growth of the atypical streptobacteria which cause souring in vacuum packed cured meats (Cavett, 1963; Spencer, 1967; Gardner, 1968). The occurrence of such potential spoilage species in the MNI brines is given in Table 1. In fresh brines 7.2% had counts between 10^1 and 10^3/ml, and in 92.8% the count was <10/ml. In recirculated brines there were as with the other counts some factory variations. The overall average was 110/ml. Counts of <100/ml were found in 78.5% of brines, but only a small proportion (2.2%) had counts exceeding 10^3/ml.

These organisms are known to occur on pork carcases (Kitchell & Ingram, 1967; Spencer, 1967) and most probably gain access to the recirculated brine from the pork being cured.

Enterococcus counts in multi-needle injector brines. Apart from being an indicator of faecal pollution, enterococci can cause spoilage of cured meats and in particular canned ham (e.g. Ingram & Hobbs, 1954), where on occasions they can cause "soft core" spoilage (Gardner, 1975b). The results of the present survey are given in Table 1. In fresh brines enterococci are rare (96.4% of brines had <1/ml), but they occur frequently in recirculated brines (24% had counts of >10/ml, of which 5.4% exceeded 100/ml). As with the aciduric lactic acid bacteria, these organisms originate in fresh pork carcases.

Discussion

Compared to fresh brines, recirculated brine from MNI machines is more heavily contaminated with micro-organisms. Species known to cause spoilage of cured meats (Vibrio, lactic acid bacteria and enterococci) were frequently found.

There were large differences in the bacteriological condition of recirculated brine both within and between factories. This is undoubtedly a result of all the associated factors, the bacteriological status of the meat being cured, which in turn is influenced by slaughter, chilling, butchery and hygiene of production, the hygienic state of the MNI machine and the degree of contamination in the fresh brine.

The effect on the keeping quality of the cured meat of contamination with spoilage bacteria during production has received only limited attention. Recirculated brines have been used for a number of years in most sectors of cured meat production without noticeable effect on shelf-life. Some experiments with vacuum packed sliced bacon, where highly contaminated injection brine was used, indicated no effect on keeping quality (Gardner, unpublished data).

Methods of reducing the microbial load in heavily contaminated brines include filtration, centrifugation, heat pasteurisation and treatment with UV radiation. The latter system usually involves filtration and in some cases dilution with fresh brine before treatment (Riordan, 1977). The obvious procedure would be to use only fresh brine, but discarding the surplus is not feasible in most situations, in that the proportion (30-50%) run to waste is so great that facilities for preparation and temperature conditioning of brine are not available. Dilution is practised in some machines, where the inlet to the machine is divided between fresh and recirculated brine. This procedure, although useful to backflush the filter head, will have little or no effect on the levels of bacteria in the brine.

The necessity for a thorough cleaning programme of MNI machines is self-evident. Build-up of meat residues will result in heavily contaminated brine. The practice of priming the machine before production and discarding the first 5-10 gallons is an added insurance.

The cardinal question of "What effect will highly contaminated brine have on the final product?" still remains in doubt. Aesthetically good manufacturing practice could not condone the injection of such brines to contaminate products unnecessarily with potential spoilage bacteria. The question of bacteriological standards for these brines is premature, until the significance of the bacteriological status has been established.

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