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HIGH TEMPERATURE PROCESSING OF PORK

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The purpose of this study was to investigate simple accelerated curing procedures, using hot boned muscle and dry curing, that could be applied in small-scale pork processing industries where technical skills are not well developed. Minced ham sausages prepared from *pre-rigor* muscle and produced within 3 hours of slaughter compared favourably with conventionally processed sausage. Shelf-life was marginally increased and product appearance improved. These results indicate that an acceptable product could be obtained by dry curing minced *pre-rigor* muscle without the need for refrigeration during the processing stages.

INTRODUCTION

One of the major factors influencing investment decisions in the development of meat processing and manufacturing industries in less developed countries (ldc's) has been the high cost of refrigeration. Recent work has shown that commercially acceptable pork products can be produced within 2-12 hours of slaughter using *pre-rigor* muscle and accelerated curing procedures: control of such procedures has proved difficult and the microbiological implications have not been fully evaluated.

In spite of the fact that ldc's utilize large numbers of livestock for meat production purpose, meat processing plants have only been introduced on a very limited scale. The bulk of the meat and by-products is still being produced and distributed locally in the fresh form, as has been customary for centuries. Yet an examination of the trade patterns

for ldc's reveals that a wide range of processed meat is imported in significant quantities [8]. During the period 1970 to 1978, imports of sausage and ham products rose steadily, by 14%, while exports fell by 11% during the same period. In 1978 alone, more than 20,000 metric tons of sausage products and 21,500 metric tons of ham and bacon products were imported by the third world at a cost of over 100 million dollars.

The countries of the Far and Near East accounted for a large proportion of this increased trade. Annual imports of sausage and ham products to the Far East are currently estimated in excess of 15,000 metric tons compared to only 9,000 metric tons in 1970; while imports to the Near East have risen threefold over the past years. This would indicate that there are a number of processing and manufacturing lines in which ldc's producers have not been adequately engaged or where their skills fall below the necessary levels. It is recognized that slaughters, for the most part, deal in a small and non-competitive range of activities and that processed meats pass through local markets in a random fashion. Those meat processing facilities that have been established are often foreign owned and serve only for export purpose.

To understand the reason for the failure of small-scale producers in ldc's to compete with imported processed meats, it is necessary to consider not only the demands of the local trader but also the nature of the cured products. Although the preservative action of salt has been recognised for centuries, and has been used in the manufacture of preserved commodities in ldc's, in recent times cured meats have come to be valued for their organoleptic quality per se and there has been a tendency to lower the concentration of salt in the curing ingredients. This has resulted in mildly cured products which are more liable to support the growth of both pathogenic and spoilage bacteria. In order to safeguard the quality of these mildly cured products curing processes of today have become more complex, involving the close control of physical parameters, such as temperature and time, and the extensive use of highly complex brine recipes. Manufactures in ldc's have been unable to supply modern cured meat products of consistently acceptable quality to satisfy the demands of selected markets for these goods. The trade therefore, has been obliged to import products at high cost, which is not only wasteful of local resources and foreign exchange, but had also led to the demise of some industrial plants that might otherwise be expected to survive on the revenues from the sales of those higher quality products. In successful plants, the revenue from the sale of goods for the luxury market has additionally been used to subsidise the price of other meats produced alongside, to create employment opportunities and to lower the cost of meat for local consumption.

If the numerous marketing, financial, technical, and operational

constraints could be overcome, benefit to the community as a whole would result from the establishment of viable small-scale processing facilities. In this study attention has been focused on one aspect of production that has, in the past, significantly influenced investment decisions: the prohibitive cost of refrigeration.

Refrigeration is employed at two stages in the manufacture of cured pork products. Immediately after slaughter, to lower muscle temperature rapidly and prevent the incidence of bone-taint in the deeper parts of the carcase, and during processing to control the rate of curing and lessen the possibility of spoilage and growth of harmful bacteria. Although the *pre-rigor* handling of meat is common in areas of the world lacking refrigeration, it is usually only for the production of fresh meat cuts and not for processed meat products.

For normal purposes the meat (internal temperature), immersion brine, and curing a llar are maintained at a temperature of between 4-5°C. Adherence to these refrigeration temperatures is important where tank or immersion curing methods are used since raising temperature above 5°C is said to involve the risk of producing excessively salt products. The reduction of curing time alone is not an effective counter measure since salt and nitrite penetration will not be sufficiently uniform to guarantee acceptable salt concentrations on the outside and good cured meat colour in the interior.

Komnarik et al. [16] patented a process for the rapid curing of bacon which involved the immersion of pork in an aqueous solution containing flavouring and anti-oxidant agents at temperatures between 3 to 5°C for 8-12 hours, followed by immersion in moving brine at 43-57°C for 5 to 10 hours. A bacon, ready for smoking was produced within 22 hours compared to $2\frac{1}{2}$-3 days using conventional procedures. Johnson and Bull [15] found that bacon produced using an accelerated cure of between 18-30 hours compared very favourably in palatability and appearance with bacon producing a standard 21 day, dry, box cure, and also with one of the top commercial brands of bacon. After brining at many different temperatures and brine strengths, they were able to conclude that the cure which compared most favourably with the dry cured bacon was a 55°C pickle for 24 hours at 49°C. Lavrova et al. [17] developed a similar technique for porcine *Psoas major* muscles, but none of the early studies considered the microbiological implications of these procedures, which are of particular concern in ham style products not cooked immediately before consumption. That work which had been carried out was confined to microbial comparisons of meat excised from carcases and processed immediately (hot processed), with that processed after conventional carcase chilling.

Pulliam and Kelley [22] carried out a study to compare "hot process-

ed" and "conventional" hams, and found higher overall bacterial counts in the hot processed hams. Barbe et al. [5] compared levels of bacteria in 19 pairs of hams of which half were processed within 15 hours of slaughter and the other half prepared following traditional methods. They found, due mainly to the rapidity of processing, major reductions in the number of aerobic bacteria in the final product. Additionally no significant bacteriological problems were revealed in hams processed using a procedure which totally eliminated chilling, both immediately after slaughter and during processing. Similar findings were reported by Barbe and Henrickson [6] and Mandigo and Henrickson [20]. They concluded that the combined effect of pH, curing ingredients, smoking, cooking, and the rapidity of handling, exposed bacteria to "maximum" lethal factors, thus effecting a reduction in the load of the final product. In tropical developing countries the public health aspects as well as the economic advantages of rapid processing, would warrant serious attention.

There are other reported commercial advantages associated with the use of *pre-rigor*, unchilled muscle for pork product manufacture. Hot muscle has a high water-holding capacity and will reduce moisture loss and produce less rendering out of fat when cooked [11]. Cure penetration and emulsifying properties have also been reported to be improved when hot boned pork is used for sausage manufacture [1, 24]. Several studies have reported differences in the rates of pre- and post-chill curing on the diffusion on curing salt. Rate of diffusion was shown to be faster in hot boned muscles and the nitro pigment conversion higher [4]. Hot cured hams were also reported to be more stable to light and thus have extended shelf life characteristics [12]. Even without the savings in yield and quality advantages, the use of rapid processing is likely to have real benefit in terms of operating and depreciation costs [7] and substantially speed up throughput and product manufacture. It would

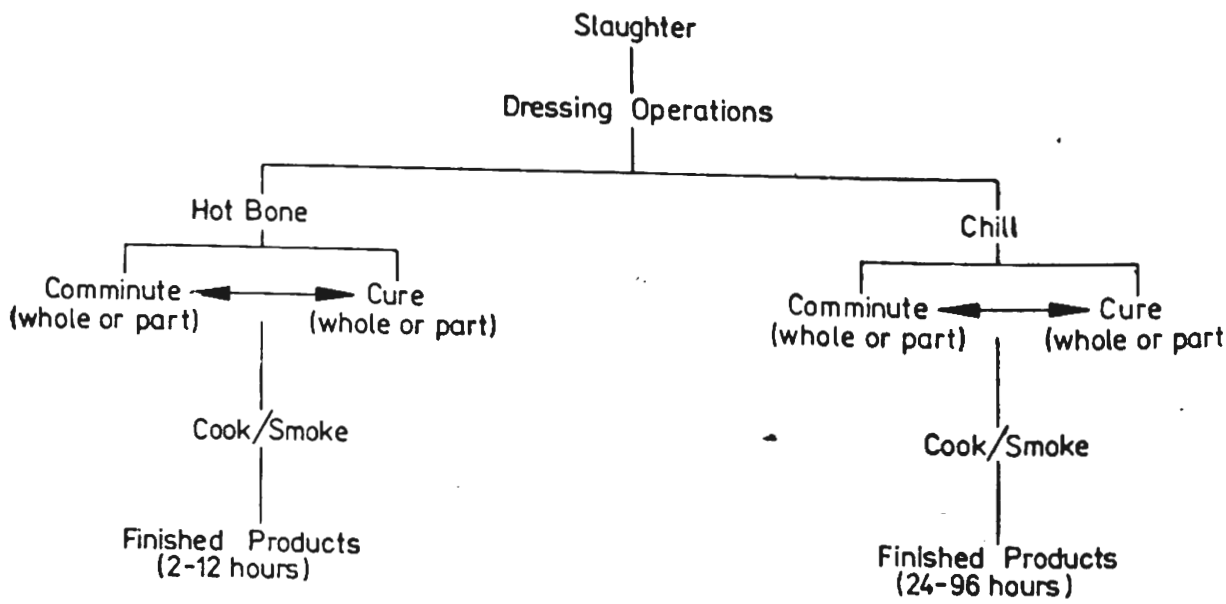

Fig. 1. Comparison of the time taken to manufacture end products from hot boned and chilled meats

be theoretically possible to market satisfactorily cured products within 2-12 hours of the pig carcase being removed of the slaughter line (Figure 1).

The object of this investigation was to develop procedures for the manufacture of a minced ham sausage using hot boning and accelerated curing techniques, and to study the effect of manufacturing procedures on the shelf life of the finished product. Processing parameters were identified which could be applied in small-scale pork processing industries in ldc's where technical skills are generally not well developed and where a refrigeration plant is usually unavailable. A minced ham product was chosen for this initial study because of the ease of manufacture and as it was felt that this product, with modifications, would find a ready market in many ldc's.

METHODS AND MATERIALS

PROCESSING PROCEDURES

Freshly slaughtered pig carcases (40-50 kg dressed weight) were collected from a commercial abattoir and transported, after splitting, to the laboratory for further processing. The left side of each carcase was placed in a cold store (3-4°C, still air) for 48 hours, while the corresponding side was hot boned. Lean meat, and back fat were carefully separated and butchery was completed within $1\frac{1}{2}$ hours of slaughter.

The chilled sides were subsequently de-boned 48 hours *post mortem* when the centre muscle temperature had reached 4 ± 1°C.

Trimmed meat from the shoulder, neck, and belly regions of the carcase was passed through a food mincer fitted with a 5 mm plate. As a greater degree of tissue separation was achieved during de-boning of the hot side, 5% (w/w) subcutaneous fat was added back to the *pre-rigor* meat during mincing.

The mince was then placed in a bench mounted mixer, the curing salt and spices added, and the ingredients thoroughly mixed for 3 minutes. The mass was then stuffed into presoaked, cellulose casings (80 mm stuffed diameter) using a hand operated stuffer. After tying-off the casings the sausages were immersed in water at 78°C, cooked to an internal temperature of 68°C (representing a cooking time of 70 minutes for a 500 g sausage), and then chilled in chlorinated cold water (1 ppm) to room temperature.

The minced ham sausages were held at three storage temperatures, 5°, 15° and 27°C for up to 21 days to stimulate good and poor refrigeration and tropical ambient temperatures respectively. At ambient temperatures the sausages were held in still air at high relative humidity (92%) to prevent surface dessication.

INGREDIENTS — MINCED HAM SAUSAGE

4.75 kg trimmed pork
0.25 kg fat
225 g salt
50 g sugar
0.5 g sodium nitrite
2.75 g ground white pepper
0.50 g garlic pepper (to taste)

ANALYTICAL PROCEDURES

Chemical analyses

All determinations were performed in duplicate and mean values recorded.

Salt, moisture, fat and ash levels were measured according to the methods of the AOAC [2].

Colour measurement — product colour on freshly exposed surfaces was assessed subjectively. In addition, photographic records were made throught the storage period on 5 mm thick slices cut on a hand operated meat slicer.

Product yield — product yields, determined by weighing the dry cured minced ham sausages before and after cooking, and during subsequent storage, have been expressed as a percentage of the initial weight after stuffing.

Organoleptic assessment — 3 mm slice of cooked minced ham sausages were presented to a semi-trained teste panel, consisting of an unchanged complement of six, at various times during the storage period.

Panelists were required to assess each with respect to the presence of off-odours, saltiness, flavour and texture. Judgements of saltiness and texture were recorded by the panelists marking an appropriate distance along two 100 mm lines, the extremes of which represented very salty to very bland and very chewey to very soft respectively.

Panelists were also required to record the presence or absence of off-odours and state whether flavour was acceptable or unacceptable.

Mean values for saltiness and texture were calculated by totalling the individual panelists scores and dividing by the number of assessments. Off-odour and unacceptable flavour assessments have been expressed as a percentage of all readings.

MICROBIOLOGICAL METHODS

Storage Trial — the bacteriological quality of both the *pre-rigor* and chilled raw minces was determined, before and after the addition of

curing salts and flavourings. After preparation and processing, sausage were transported overnight, in ice, to the microbiology laboratory. On arrival, day 1, one sausage was removed from the batch and examined immediately.

The remaining sausages were divided into three lots and stored at 5°, 15° and 27°C. Changes in levels of the bacterial flora including the pathogens *Staphylococcus aureus* and *Clostridium* spp. were monitored at regular intervals during storage: sausages stored at 5°C were examined after 4, 8, 11, 14, 18, and 21 days; samples of sausages stored at 15°C were taken after 4, 8, 11, 14 and 18 days; and sausages stored at 27°C were examined after 2, 3 and 7 days.

Three storage trials were carried out for both *pre-rigor* and chilled meat sausages. The bacteriological results recorded in this paper represent the mean of these three trials.

Inoculation study — in order to determine the effectiveness of the combined effects of nitrite, salt, pH and temperature in controlling the growth *Clostridium botulinum* in both the *pre-rigor* and chilled meat sausages, an inoculation study was carried out. A standardised incolum of *Clostridium sporogenes* (NCTC 10696), a non-toxic anaerobe culturally similar to proteolytic strains of *C. botulinum*, was added to the minced pork together with the curring salts and flavourings. Sausages were then prepared and processed and described previously. After this, one sausage was examined on day 1^{-st} and the rest were divided into 2 lots and stored at 5° and 15°C. Further samples were taken on days 2, 7 and 14 in order to determine the level of *C. sporogenes* in the sausages.

Sampling — sample units of 30 g were removed from the bowls containing *pre-rigor* and chilled minced pork, both before and after the addition of curing salts and flavourings. Also, a whole cooked sausage was removed from storage and sampled on each of the pre-arranged days. The 30 g sample was taken by removing sectors from slices cut across the length of the 500 g sausage. Thes 30 g samples were each placed inside a sterile stomacher bag, to which 270 ml 0.1% peptone diluent was added. The contents were mixed together in a Colworth Stomacher for 1 minute to give the initial 10^{-1} dilution [13].

From each initial dilution a ten-fold dilution series was prepared, using 9 ml quantities of 0.1% peptone in universal containers as the diluent, and this was used to inoculate the tests listed below.

Assessment of the level of bacterial contamination

Total aerobic count — total counts, expressed as the number of colony forming units (cfu) per gram sample, were made at 30°C by the spread plate technique using plate count agar as the culture medium. The number

of cfu which had formed were counted after 3 days [13].

Anaerobic count — the rapid drop plate technique of Miles and Misra [21] was used for the anaerobic count, with horse blood agar as the culture medium. Plates were incubated in a Gas Pak anaerobic jar at 30°C and the number of cfu were counted after 3 days.

Coliform count — the number of coliform bacteria was determined on violet red bile agar. Plates were incubated at 35°C and the number of cfu counted after 24 hours [13].

Spoilage bacteria

Lactobacilli were enumerated on MRS agar [18] using the spread plate technique. Plates were incubated in a 5% CO_2 environment at 30°C and the number of cfu counted after 3 days.

Members of the *Pseudomonaceae* were enumerated by the spread plate technique on Mosurovsky's Medium [19]. Plates were incubated at 27°C and the number of colonies with the characteristic appearance of *Pseudomonas* spp. were counted after 3 days.

Brocothrix thermosphacta [23] (*Microbacterium thermosphactum*) was enumerated on Streptomycin Thallous acetate, Actidione Agar (STAA) [9] using the spread plate technique. Plates were incubated at 27°C and the number of oxidase negative colonies counted after 3 days.

Bacteria of Public Health significance

The presence of *Staphylococcus aureus* was determined quantitatively on Baird-Parker medium and quantitatively by an enrichment procedure in 10% salt meat broth [13].

Direct plate counts for *Clostridia* were made on lactose egg yolk agar [25]. In addition an enrichment procedure with cooked meat medium was used [13].

Confirmatory tests for both *S. aureus* and *Clostridium* spp. were carried out following methods recommended by the ICMSF [13].

RESULTS AND DISCUSSION

The *pre-rigor* and chilled minced pork used to prepare the sausages were of an acceptable bacteriological quality (Table 1). The *pre-rigor* meat had a lower count for aerobic mesophiles (10^4 cfu/g) than the chilled meat (10^6 cfu/g). Similarly, numbers of *Pseudomonas* spp. and coliform bacteria were also lower in the *pre-rigor* mince than in the corresponding samples of chilled mince. *Lactobacilli*, *C. perfringens* and *S. aureus* were present in both types of meat at approximately the same levels. *B. thermosphacta* was present in the *pre-rigor* pork in low levels, but was not detected in the chilled meat.

Table 1. Microbial counts of *pre-rigor* and chilled meat before processing

		Colony forming units/g		Colony forming units/g				*Staphylococcus aureus*		*Clostridium* spp.	
		Aerobic Mesophiles	Anaerobic Mesophiles	*Pseudomonas* spp.	*Broxothrix thermosphacta*	*Lactobacilli*	Coliforms	c. f. u. /g	Enrichment	c. f. u. /g	Enrichment
Pre-rigor	Minced without salt	2.2×10^4	1.0×10^4	1.8×10^2	2.0×10^2	2.7×10^3	< 100	1.0×10^2	PRESENT IN 1g	1.0×10^2	PRESENT IN 1g
	Minced with salt	2.3×10^4	6.0×10^3	4.0×10^2	1.5×10^2	2.0×10^3	< 100	1.0×10^2	PRESENT IN 1g	< 100	NOT DETECTED IN 1g
Chilled	Minced without salt	1.1×10^6	9.0×10^3	2.6×10^6	< 100	1.3×10^4	4.0×10^5	3.5×10^2	PRESENT IN 1g	6.0×10^2	PRESENT IN 1g
	Minced with salt	2.5×10^5	9.5×10^4	1.0×10^5	< 100	3.6×10^3	1.2×10^2	3.0×10^2	PRESENT IN 1g	< 100	NOT DETECTED IN 1g

The number of cfu present on a carcase will be representative of the way in which the carcase has been handled during slaughter and dressing. Gill and Penny [10] have shown that the immune response mechanism is active in the carcase after slaughter, and that bacteria present in the tissue during the first hour after death are destroyed and can be totally eliminated. They have also shown that surviving vegetative cells of *C. perfringens* do not actively grow until 3 hours from the time of slaughter and that outgrowth of spores does not occur until 8 hours after slaughter. This property of meat can be used to the full advantage with *pre-rigor* products: by preparing and processing products under hygienic conditions as quickly, efficiently and as close to the time of slaughter as is possible the end product should be of an extremely good bacteriological quality.

The chilled pork, which had been held in a refrigerator for 2 days

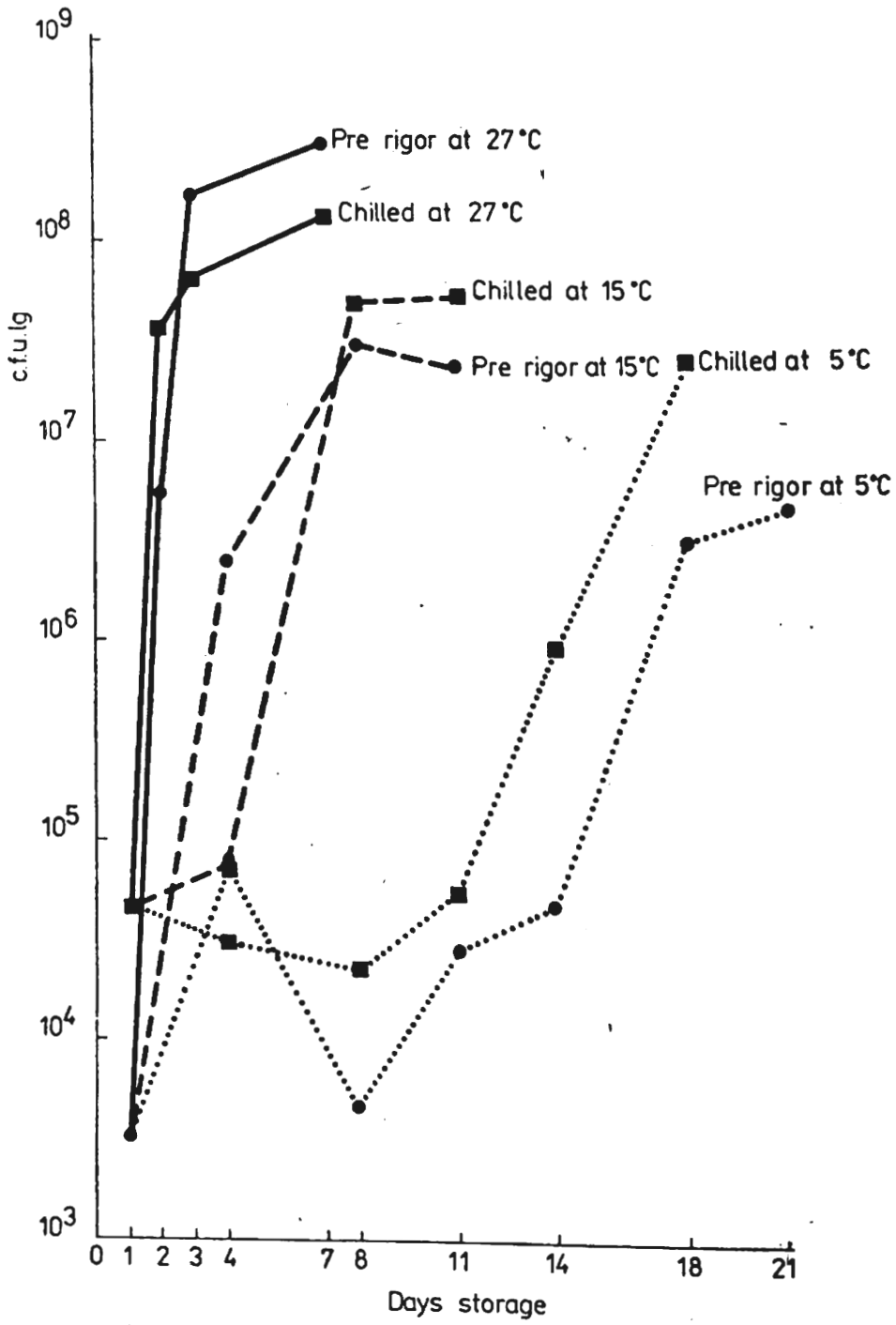

Fig. 2. Rate of spoilage of sausages stored at 5°, 15° and 27°C

prior to processing, had an increased bacterial load in comparison to the *pre-rigor* pork. The number of psychotrophic bacteria had increased, as can be illustrated by the level of *Pseudomonas* spp. present.

After processing total counts of the cooked sausages fell to $3.6 \times \times 10^3$ cfu/g, in those prepared from *pre-rigor* pork, and to 4.3×10^4 cfu/g, in those prepared from chilled meat (Fig. 2). Therefore both types of sausage were within the limits of 10^4 cfu/g or less, as recommended by the American Public Health Association [3] for cooked cured meats.

Upon storage, the *pre-rigor* sausages held at 27°C were not acceptable after 2 days storage. *S. aureus* (Fig. 3) and *C. perfringens* were seen to be actively growing in the sausages, and therefore constituting a possible health hazard. Similarly, sausages stored at 15°C were not acceptable after 4 days storage by which time the total count had increased to 1.2×10^6 cfu/g. *S. aureus* and *C. perfringens* were also isolated from all

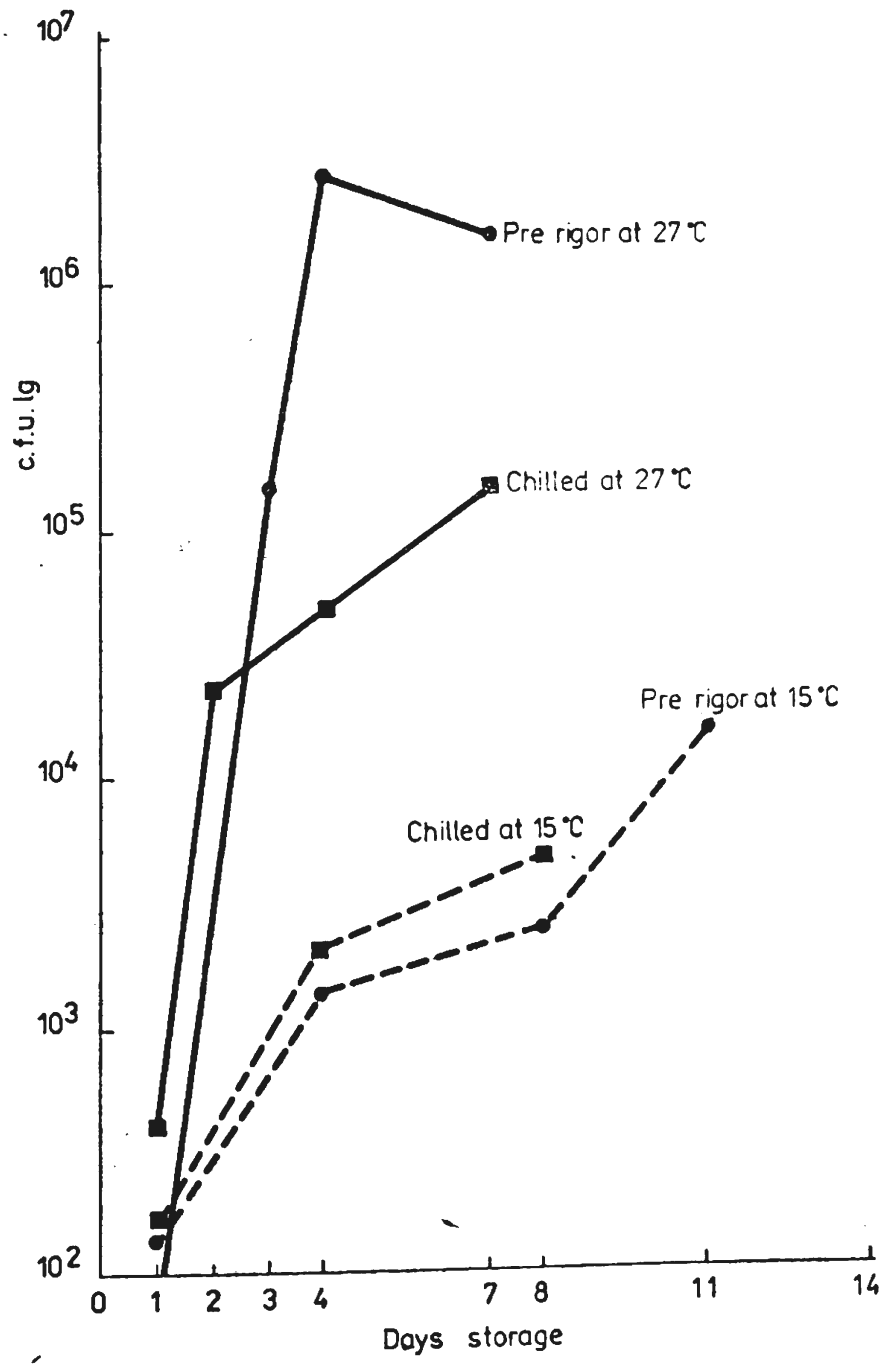

Fig. 3. Increase of *Staphylococcus aureus* in sausages stored at 15° and 27°C

samples stored at 15°C after and including day 4. *Pre-rigor* sausages stored at 5°C were acceptable up to 14 days, after 18 days storage the count had reached 2.8×10^6 cfu/g and they were considered to be bacteriological unacceptable. *S. aureus* was not isolated from any of these samples; *C. perfringens* was isolated in insignificant numbers (< 100 cfu/g) from the sample taken on day 8 of the trial.

Of the sausages produced after carcase chilling: those stored at 27°C were not acceptable by the second day. The total count was 3.6×10^7 cfu/g and the level of *S. aureus* increased as the storage trial progressed, to 1.6×10^5 cfu/g by day 7 (Fig. 3). *C. perfringens* was isolated in low levels, < 100 cfu/g, only from the sample taken on day 1. Sausages stored at 15°C were of a slightly better bacteriological quality after 4 days than the corresponding *pre-rigor* sausage (Fig. 2). However, by day 8 they were considered to be beyond the limit of acceptability with a total count of 4.8×10^7 cfu/g. *S. aureus* and *C. perfringens* were isolated from all samples. Sausages stored at 5°C were of an acceptable bacteriological quality up until 11 days storage. By day 14 the total count had increased to 9.4×10^5 cfu/g. *S. aureus* and *C. perfringens* were isolated in low numbers, 100 cfu/g, from sausages tested on days 1, 4 and 8.

To add to this data, results of the inoculation study with *C. sporogenes* (NCTC 10696) showed that the process and subsequent storage of sausages prepared from both *pre-rigor* and hilled pork, resulted in a gradual reduction of viable *C. sporogenes* (Fig. 4) cells. However, 100 ppm nitrite and 3.5% NaCl (w/w), the initial levels used in these experiments, have been shown to be less than 100% effective in inhibiting the growth of

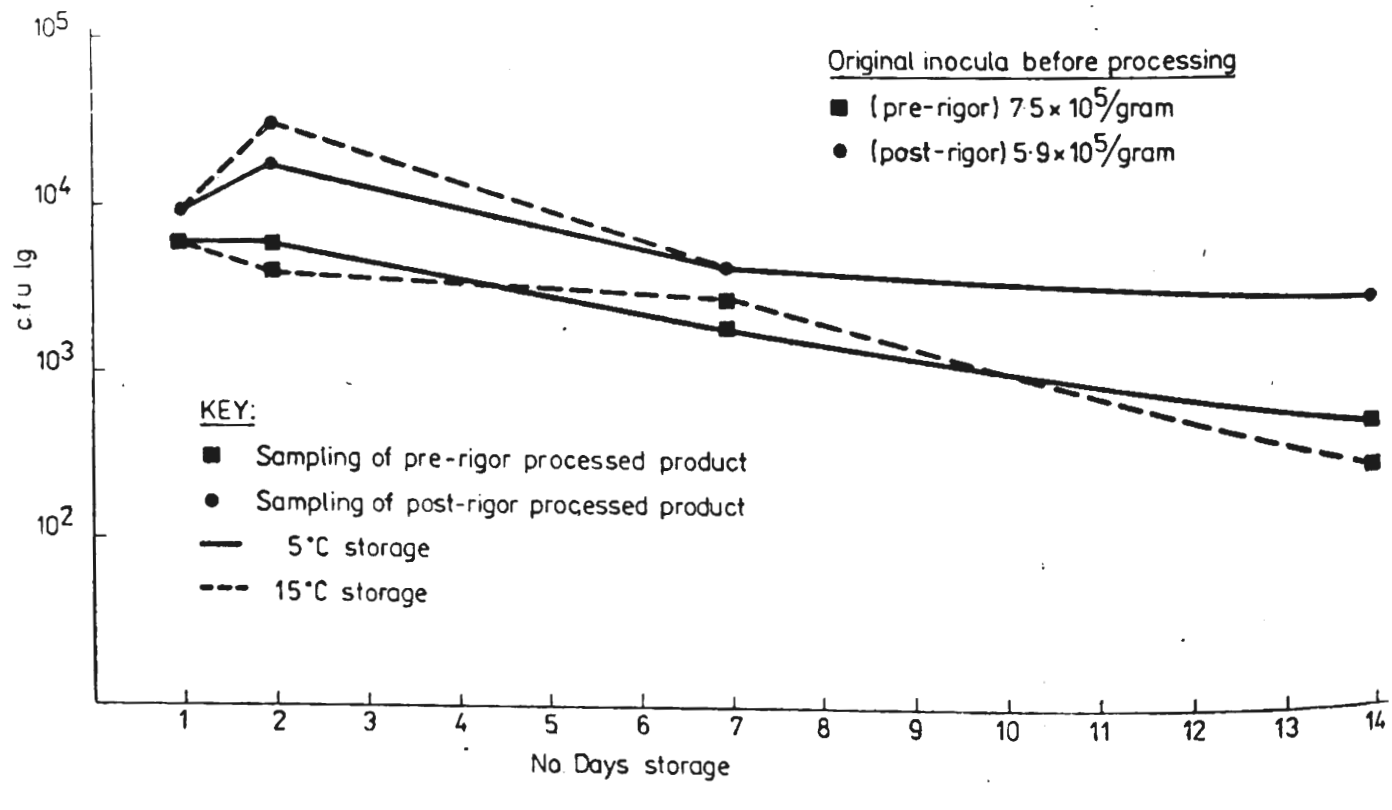

Fig. 4. Recovery of *C. sporogenes* (NCTC No. 10696) from inoculated *pre-* and *post-rigor* processed products store at 5° and 15°C

C. botulinum and toxin production at 15°C [14]. Other workers have shown that *C. perfringens* and *S. aureus* will not be able to grow in cooked cured sausages, when stored at 5°C [3].

Therefore minced ham sausages, prepared from either *pre-rigor* of chilled pork, need to be stored below 5°C in order for the product to be considered safe for human consumption.

There was little effect of *pre-rigor* processing on the chemical composition of minced sausage. Good separation of the substaneous and intermuscular fat deposits during hot boning resulted in lower fat levels in products made from this material, despite the subsequent addition of 5% fat. Final salt levels of 3.8 to 3.9% are higher than those normally expected in modern cured products (Table 2).

Table 2. Chemical composition

Treatment	Moisture %	Fat %	Ash %	Protein %	Salt concentration (as % wet tissue weight)
Pre-rigor processed	68.0	8.8	4.5	17.7	3.9
Processed after chilling	64.5	11.2	4.5	18.8	3.8

The marginally higher product yield of the *pre-rigor* processed sausages after cooking agrees with findings of Hamm [11] that sausages made from unchilled muscle will have a higher water holding capacity and produce less rendering out of fat when cooked. Subsequent moisture loss during storage was also slightly lower in these products, 15% versus 20% for the conventionally processed sausages over the 14 day storage period 5°C (Table 3).

Table 3. Product yield, sausages stored at 5°C

Treatment	Yield after cooking	Yield during storage (%) at 5°C			
		1 day	3 days	7 days	14 days
Pre-rigor processed	100.6	98.7	96.6	92.5	84.9
Processed after chilling	98.9	95.5	92.9	87.7	78.5

The results of organoleptic trials showed no significant differences between treatments in saltiness during storage at either 5° or 27°C; despite the moisture loss and reductions in product weight (Table 4).

Textural differences in products stored at 5°C were marked. The *pre-rigor* processed sausages were dryer and firmer in texture and generally were judged to have improved appearances. The differences

Table 4. Organoleptic evaluation

Treatment	Temp. of storage °C	Days of storage	Saltiness 0 = bland 10 = excess salt	Texture 1 = v. soft 10 = v. chewy	Percentage absence of off-odours	Acceptability absence of off-flavours
Pre-rigor processed	5°C	1	6.2	5.9	83	83
		2	5.5	5.4	83	83
		5	4.8	3.9	100	83
		7	4.9	4.2	100	83
	27°C	1	5.3	5.2	100	83
		2	5.5	5.5	66	83
		5	5.8	6.3	50	66
Processed after chilling	5°C	1	5.6	3.4	83	83
		2	5.0	3.6	100	83
		5	5.0	3.6	100	83
		7	5.1	3.4	83	100
	27°C	1	5.7	4.4	83	83
		2	5.5	4.5	66	66
		5	4.8	6.3	50	50

between treatments were masked in those sausages stored at 27°C presumably because of the excessive drying concomitant with the increased weight loss at the higher temperatures.

Increased percentage scores recording the presence of off-odours and off-flavours were noted in all sausages stored at 27°C. Less understandably, at least half of the taste panel members were unable to detect these off-odours and flavours even after 5 days storage at 15°C, when microbiological levels were in excess of 10^7 cfu/g. Sausages stored under refrigeration acceptable throught the trial period.

CONCLUSIONS

It would appear from this study that there is no great risk to health from the consumption of a *pre-rigor* processed sausage as long as it is stored under refrigeration. In fact, the bacteriological results show the *pre-rigor* processed sausage to have a slightly longer shelf life than the conventionally processed sausage held at 5°C. In addition the organoleptic assessments for texture show a preference of *pre-rigor* over chilled sausage when stored at 5°C. Why therefore have hot boning and hot processing technologies not been introduced into ldc's?

One explanation for the reluctance of third world countries to develop

pre-rigor processing technology is that hot processing demands careful consideration of hygienic procedures, which in general is one of the least noteworthy features of slaughter in the tropics. Movement of contaminated material from the slaughter floor to the processing room is a real possibility in a poorly managed and badly designed abattoir and must be prevented at all cost if the spread of food poisoning organisms is to be avoided.

Furthermore, meat to be used in sausage manufacture must be derived from healthy animals that have been subjected to *ante-* and *post-mortem* inspection by a trained inspector. The application of such elements of meat hygiene cannot simply be entrusted to butchers and processing staff since they are primarily concerned with production problems, profits and other interests not always consistent with good practices of food handling. In the absence of adequate facilities and trained staff, most meat technologists have been loath to recommend the adoption of hot processing in all but a few of the more advanced developing countries.

Although the authors acknowledge that the general situation remains essentially unchanged, knowledge of new processing procedures, particularly where refrigeration practice is concerned, has an important bearing on investment decision on new abattoir and processing hall construction. A substantial part of the cost of a new abattoir or meat processing plant, complying to modern meat handling practice, is associated with chill room requirements. Modernisation and rebuilding programmes have often been deferred simply because of the high cost of refrigeration plant and associated services.

The purpose of the study was therefore to illustrate the potential for this type of technology rather than to recommend its immediate application.

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PRZETWÓRSTWO WIEPRZOWINY ODKOSTNIONEJ NA CIEPŁO

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Streszczenie

Przeprowadzone badania wykazały, że kiełbasa z mięsa odkostnionego na ciepło odznaczała się większą trwałością przy przechowywaniu w 5°C w porównaniu z kiełbasą otrzymaną metodą tradycyjną. Dotyczyło to także tekstury, która w tych warunkach była lepsza z mięsa odkostnionego na ciepło.

Odkostnienie na ciepło stawia jednakże duże wymagania w zakresie higieny uboju. Przenikanie zanieczyszczeń z posadzki hali ubojowej do działów przetwórczych stwarza poważne niebezpieczeństwo rozprzestrzeniania się bakterii chorobotwórczych. Fakt ten tłumaczy stosunkowo małe zainteresowanie krajów rozwijających się technologią mięsa odkostnianego na ciepło.

Niezależnie od tego mięso przeznaczone na kiełbasy musi pochodzić od zwierząt zdrowych, które poddane muszą być badaniom weterynaryjnym przed i po stężeniu pośmiertnym. Nie zawsze można oczekiwać, aby wymienione elementy higieny i kontroli były przestrzegane przez drobnych przetwórców. Dlatego technologia mięsa odkostnionego na ciepło może być zalecana w krajach bardziej rozwiniętych i w zakładach o odpowiednio wysokim poziomie higieny i techniki oraz odpowiednich rozwiązaniach przestrzennych hali ubojowej i oddziałów technologicznych.