Hygienic Quality of Raw Pork and Chorizo (Raw Pork Sausage) on Retail Sale in Mexico City

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ABSTRACT

A survey of raw pork and a raw fermented pork sausage, chorizo, was undertaken in Mexico City to assess the hygienic quality of these two products on retail sale in a variety of outlets. Total bacterial counts and Enterobacteriaceae counts were determined and the samples were analyzed for the presence of Salmonella spp. Pork sold from refrigerated display cabinets in supermarkets and butchers' shops was of a poor microbial quality similar to that sold in street markets. In all types of outlets, a high proportion (76%) of samples contained Salmonella spp. Hygiene scores for vendors did not correlate with microbiological quality. For chorizo, the microbial quality was related to the type of producer. The product of major commercial companies had a lower mean Enterobacteriaceae count than that of small-scale producers, but although this difference was statistically significant, counts were high for a fermented meat product. Twenty percent of chorizo samples from major producers were positive for Salmonella spp. Small-scale or "back-shop" production resulted in 72% of samples being positive for Salmonella spp. Thus neither type of chorizo could be described as being a good quality and hygienic product. It is apparent that both animal husbandry and slaughtering procedures for pigs require further study, as does the pork-processing industry, in order to define how the meat becomes so heavily contaminated. Improving the quality of the raw meat will benefit consumers in the Mexico City area and will be an essential prerequisite for improving the quality of chorizo.

Key words: Hygiene, meats, retail, salmonella, Enterobacteriaceae

During 1992, in the metropolitan area of Mexico City (population approximately 25 million) about 65,000 cases of foodborne intoxication and 3.5 million cases of enteritis were reported (3). Contaminated foods were reported as an important vector in many of these cases with Salmonella spp. epidemics frequently noted. Causes of the epidemics were usually ascribed to bad handling and preparation practices, as food handlers generally have only the most basic ideas of hygienic practices, and may themselves be carriers of Salmonella (3, 29). Meat and meat products have been implicated frequently in outbreaks of salmonellosis (8, 10, 24, 26).

Pork is one of the most important meats in the Mexican diet and pork products are eaten widely, both for cultural reasons and because of their relatively low cost. Chorizo is a very popular pork product due to its sensory properties and price. It is a fresh sausage, generally prepared from a mixture of minced pork and fat, to which salt, spices, paprika, and peppers are added. Sometimes curing salts and sugars are added to the mix. The prepared material is stuffed into casings (either natural or artificial), and a spontaneous lactic acid fermentation takes place. Although some enterprises may use starter cultures, most producers rely on the indigenous flora. The product is highly variable as recipes differ from region to region and the proportion of vegetable matter may often be increased to reduce costs. The resulting sausage (5 to 15 cm long and 3 to 5 cm in diameter) is bright red with a distinctive aroma and is sold either fresh or after a period of ripening. The purchased product may also be stored under ambient conditions with sections removed for cooking as required; hence it may be consumed at different states of ripening.

Because the preparation of chorizo requires no expensive equipment or technology, it is produced extensively by large companies and small butchers' shops or retailers. This product may be a means of retailing less marketable meat. Since raw pork and chorizo are eaten widely, a survey was initiated to investigate the hygienic quality of these products available in large supermarkets, butchers' shops, and open street markets. The aim was to obtain basic microbiological information on these two products in the local diet to subsequently improve their hygienic quality.

MATERIALS AND METHODS

Sampling

From January to March 1994, 50 samples of raw pork were purchased at randomly selected retail sites in Mexico City, including supermarkets, butchers' shops, and street markets. Half of the samples were bought from sites lacking refrigerated storage facilities, and half from those possessing refrigeration. Similarly,
50 samples of chorizo were collected: 25 produced in industrial units under brand names, and 25 prepared in small “back-shop” operations. Information on hygienic conditions of the samples and sites, including display and product temperatures was collected. A scale from 1 (good) to 4 (poor) was used to assign hygiene scores to the premises on the basis of observed compliance with recommended practices (34). Samples were transported to the National Public Health Laboratory (LNSP) in chilled and insulated boxes and were kept under refrigeration (3°C) until microbial analyses were conducted (usually 18 to 24 h). Normally ICMSF (19) guidelines were followed when sampling.

Microbial analysis

Except where indicated, LabM (Amersham, Bury, UK) media were used throughout the investigation.

For microbial counts, an initial sample (10 g) of product was blended in 90 ml of peptone saline diluent, and 10-fold dilutions plated onto nutrient agar (NA) for total viable counts (TVC). Both DeMan, Rogosa, Sharpe (MRS) agar and M17 agar were used for isolating lactic acid bacteria (LAB). Enterobacteriaceae were enumerated using pour plates with an overlay of violet red bile agar with glucose (10 g/l) (VRBGA). All plates were incubated at 35°C. VRBGA plates were incubated for 24 h, and the others for 48 h.

Due to limited resources, a protocol simplified from ISO 6579: 1993 (20) was used to isolate Salmonella spp. Samples (25 g) were homogenized in 225 ml of buffered peptone water and then incubated overnight at 37°C before 0.1-ml aliquots were inoculated into Rappaport-Vassiliadis Broth (10 ml) and incubated for 24 h at 42°C. Both brilliant green agar and xylose lysine deoxycholate agar were used as plating media. A rapid test, Rapidec Z system (BioMerieux, Lyon, France) was used for initial biochemical confirmation. Two or three positive cultures from each sample were maintained on NA slopes, and transported in vials of soft NA to Belfast for detailed biochemical analyses and serological identification. Cultures were plated and checked for purity before cryopreservation on plastic beads (Protect, STC, Lancashire, UK) at −80°C. Serological confirmation and typing was by conventional methods (20), using the appropriate Salmonella spp. poly- and monovalent agglutinating sera (series ZC and ZD, Murex Diagnostics Ltd, Dartford, UK) to perform somatic (O) and flagellar (H) agglutination reactions.

Regression and variance analyses (Genstat 5, 2.2. Vax/VMS) was carried out by Biometrics Division, DANI, at Newforge Lane.

RESULTS AND DISCUSSION

Pork

No differences were found in the incidence of Salmonella spp. in raw pork samples taken from refrigerated and unrefrigerated displays, with 38 of the 50 pork samples (76%) proving positive in both cases. The methods used to isolate and provisionally identify the Salmonella contamination were satisfactory, as all but 1 of 135 presumptive isolates were confirmed as Salmonella spp. TVC and Enterobacteriaceae counts of both refrigerated and unrefrigerated pork samples also showed no statistically significant differences (P > 0.05), although counts of both groups of microorganisms were slightly lower in the samples of refrigerated meat (Fig. 1 and Fig. 2). In both butchers’ shops and in the open markets, practices that are well documented as increasing the bacterial load and causing cross-contamination (7, 9) were commonly observed. These included exposure of the product to the open air, inappropriate or dirty surfaces in contact with the meat, different kinds of products including cooked meats and dairy products stored together, the same equipment used for all of the products without cleaning, continuous exposure of products to high ambient temperatures, and alternate handling of products and money. Thus, the poor hygienic status of the product from those sites is not surprising.

However, in the supermarkets conditions were apparently more hygienic and all of the products under investigation were packed in trays and covered with plastic film. Although meat was always held in refrigerated display units, the mean temperature of the refrigerated product was 14°C indicating that the cooling was inadequate and insufficient to control microbial growth (16, 28). In agreement with similar studies (27, 36–39), analysis of variance indicated no
correlation between the hygiene scores and the microbiological analyses, although there was correlation with the price of the pork; higher prices generally meant higher hygiene scores for the vendor’s premises, but not a safer product.

These high levels of Salmonella contamination imply that local conditions of animal husbandry are likely to increase the incidence of the pathogen in the pig population. This high incidence would then lead to the high rate of contamination of raw pork attributed to contamination at evisceration, or to subsequent cross-contamination. Cross-contamination from handlers must also be evaluated further, as local studies have reported over 13% of food handlers to be Salmonella spp. carriers (3, 29).

Although S. derby and S. anatum were among the most commonly reported serotypes isolated from foods during 1974 to 1981 (17), in this study no defined pattern of serotype distribution was observed in raw pork (Table 1). Moreover, in 38% of the 61 Salmonella-positive samples, more than one serotype was present. Hence a wide distribution of this pathogen with no clearly identified source indicates its endemic character.

Raw pork from the Mexico City area was of poor microbial quality regardless of the retailing conditions and, given the high frequency of isolation of Salmonella spp., it is clear that all aspects of pork processing require further study. The introduction of good hygienic practices would help to ensure that all consumers receive safe meat, although currently accepted good practice may not be enough to provide a product of good microbiological quality (15).

**Chorizo**

Given the poor microbiological quality of the raw pork, it is not surprising that the chorizo was also of poor quality. No discussion of TVC results is possible due to the overgrowth by LAB colonies. The type of chorizo being produced exerted a major influence on the microflora with significantly lower VRBGA counts ($P < 0.001$) observed with the “branded” chorizo (Fig. 3). The price of the chorizo was related to neither VRBGA counts ($r = -0.13, P > 0.05$) nor the presence of Salmonella spp. ($P > 0.05$). Although most of the product labels advised the refrigerated storage of sausages, all samples obtained were at room temperature (mean 21°C) when sampled.

The apparently more effective nature of the industrial fermentation process is reflected in the lower incidence of Salmonella spp. which resulted in a statistically significant association ($P < 0.001$) with the type of production premises. Only 20% of Salmonella spp.-positive samples were found in the industrially produced sausage compared to 72% incidence in samples from “back shop” producers. Thus the “branded” product showed a marked reduction in the presence of Salmonella compared to the levels observed in raw pork.

An initial concern at this stage was that the simplified methodology used could have resulted in an underestimate of the levels of Salmonella spp., but some 76% of samples proved positive. Other workers in Mexico have reported a lower incidence of Salmonella (35%) in pork (5), and 28% incidence in raw meats (25). However, Fernandez-Escartin et al. (13) found 87% of pork samples to be positive, and Bello and coworkers (4, 5) reported a 47% incidence of Salmonella spp. in 1990 and 41% in 1991 in chorizo and longaniza, which is comparable to the 46% found in this study.

The 17 different Salmonella spp. serovars isolated from...
chorizo are widely distributed and no specific pattern could be recognized (Table 1), as was the case for isolates from raw pork.

The observed lower Salmonella isolation rates from industrially produced chorizo, compared with pork, are probably due to the effects of the LAB fermentation, since antagonism of LAB towards Salmonella spp. is well known (14). However, some authors have found that coliforms (22) and Salmonella spp. (2, 30, 35) can survive in sausages after fermentation. Studying chorizo microbiology, Domínguez et al. (11) observed the sequential inhibition of coliforms during the drying stage, which may explain why most Salmonella isolates from chorizo were found in softer sausage. These observations are in general agreement with those of Martinez et al. (22), who found that in dry chorizos, coliforms are present exclusively on the casings. The differential incidence of Salmonella spp. and Enterobacteriaceae in samples (Fig. 4) may indicate different degrees of resistance to chorizo processing conditions, with coliforms being relatively more sensitive.

Small-scale production of chorizo yielded products of poor microbial quality. Safer sausage apparently is produced by larger commercial units, but further work is still required to ensure that this product is pathogen free. A controlled drying process may be a good approach to improve the safety of chorizo, but the time and cost will have significant economic implications. Applying a variety of food preservation techniques, such as the use of additives including sorbates and glucono-δ-lactone (18, 30) and/or starter cultures (1, 6, 23, 33) to ensure adequate acidification, may provide additional hurdles to microbial growth and/or survival in such products (32). However, changes in formulation and, consequently, in microbiological populations of fermented products, can significantly affect the sensorial characteristics of the product (21) and these effects on the market have to be considered (12).

The lack of a defined pattern of Salmonella spp. serotypes in both the raw pork and the fermented chorizo would seem to indicate that a variety of sources of Salmonella spp. contamination exist throughout the meat production and processing system. It is, therefore, essential that appropriate steps be taken to define and eradicate such sources. Consumer education is also required to ensure appropriate cooking of these common commodities.

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REFERENCES


