Saprophytic and Pathogenic Bacteria Levels in Turkish Soudjouks Manufactured in Erzurum, Turkey

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ABSTRACT

In Turkey, spicy, typically dry, fermented sausage (soudjouk) is one of the most popular processed meat products. In this study, 42 soudjouk samples were collected from the eight manufacturers in Erzurum, Turkey. These samples were evaluated for aerobic plate count (APC) at 37 and 25°C, psychrotrophic, coliform, Escherichia coli, and coagulase-positive Staphylococcus aureus counts and presence of Salmonella and Shigella spp. Generally, all the samples had very high counts of most of the bacteria enumerated. In two samples of the 42, Shigella spp. was found and one of them was Shigella boydii. None of the samples yielded Salmonella spp.

The microbiological load and the profile of processed and/or ready-to-eat meat products such as bologna, frankfurters, Brűhwurst, Kochwurst, Rohwurst, liver cheese, variety loafs, ham or ham-like products and other pork products, canned products, poultry, roast beef and dried fish is of public health concern and their investigation have resulted in numerous publications world-wide (1,2,8,9,13,19,22,25,28). Several states in the United States and many other countries of the world have been working on the bacteriological quality of their meat products for a long time. Some of them have already established guidelines or standards have been suggested and some others are seriously considering them (6,19,21,22,23,28,30,31,38).

In Turkey, among the processed meat products, the product produced in the largest quantities is Turkish soudjouk (4,16). Turkish soudjouk is a spicy, typically fermented sausage manufactured from beef, water buffalo meat and/or mutton. Soudjouk mixtures also usually contain 10% fat from fat-tailed sheep (11,15,26). The soudjouk mixture is generally filled into a bovine small intestine casing and ripened at 14-27°C with 80-95% RH (relative humidity) for approximately 10-20 d. The processing conditions vary considerably, depending on the particular meat plant and manufacturer (11,15,16). Due to lack of knowledge of processing technology and standardized methods, soudjouk has generally been processed under rather primitive conditions. This limitation in technology often results in the production of spoiled and faulty products during and/or after the ripening (11,15,27,37).

Due to the variation in processing procedures, a very high count for different saprophytic and pathogenic bacteria is often obtained. Inal (20) stated that marketed soudjouks had a high and varied bacterial flora; Ozalp and Ozalp (27) found 1.1 × 10^6 to 4.1 × 10^{10} total bacteria/g in soudjouk samples and Yildirim (37) noted that soudjouks had very high total proteolytic and lipolytic counts during and after the ripening period. Because of limited and inadequate data in this area there is currently no proposed standards for the bacteriological level of soudjouks.

The objective of the present study was to determine the level of some bacterial groups in the soudjouk samples generally produced or sold in Erzurum; and to encourage further research on this subject and to gather data for possible microbiological standards. The city of Erzurum was chosen because Erzurum is one of the major cities where large volumes of fresh and processed meat products, especially soudjouk, are processed and exported to other cities.

MATERIALS AND METHODS

Materials

A total of 42 [(5 months × 8 categories) + 2 additional samples] soudjouk samples were systematically collected, one per month, between October, 1984 and February, 1985 from three large manufacturers (coded M, O and P which represents the State Meat Plant in Erzurum), from three medium-sized manufacturers (coded K, L and N), from small butcher shops (an additional sample was taken for this category) which were grouped together and labeled as R, and from shops (an additional sample was taken for this category) in the lower economic section of the city which were grouped together and labeled as S. A soudjouk link was randomly and aseptically
collected at four intervals (to reduce the number of samples analyzed at each time period) in each month and analyzed immediately. Most media and standards used were products of either Difco or Oxoid laboratories and biochemical reagents were prepared in our laboratories.

**Enumeration and isolation**

The casing was removed with a sterile knife and the soudjouk was then ground in a small, sterile grinding machine. Then a 25-g sample of soudjouk was aseptically weighed into a sterile blender containing 225 ml of sterile peptone water (0.1% w/v) (PW) and blended for 2 min at low speed. Further decimal dilutions were prepared in PW. Bacteriological analyses were generally conducted according to those published in Bacteriological Analytical Manual (12) except where minor modifications were deemed advantageous. In pour-plate methods for each organism appropriate dilutions were used and duplicate plates prepared. Tryptone glucose extract agar (TGEA) (Difco) was used and the incubation condition was 35°C/48 h (16).  

**RESULTS AND DISCUSSION**

The bacteriological profile of the total 42 soudjouk samples is shown in Table 1. Population ranges, number and percentages of the samples falling in each range are summarized. As seen from data in the table, in general, some samples indicated a wide range for the different bacteria types that were enumerated. Due to the lack of literature values concerning the microbiological counts for soudjouk, these findings could not be compared with published data. However, these findings are generally much higher than the bacteria levels of other common processed meat products of many countries (1,2,8,9,13,22,28).

The APC at 37 and 25°C incubation and psychrotrophic counts could be considered an indication of the wholesomeness of the product and these microorganisms could affect the purification of the samples. Approximately 60% (37°C) and 72% (25°C) of the samples indicated higher than 107 APC/g and 45% of the samples resulted in a value higher than 107 psychrotrophic counts/g. The mean value of the APC at 37°C incubation was $1.6 \times 10^8$/g and the maximum and minimum values were $6.2 \times 10^6$ and $1.0 \times 10^7$/g, respectively. APCs at 25°C incubation were: mean $3.5 \times 10^9$/g, maximum $7.2 \times 10^9$/g and minimum $3.8 \times 10^9$/g. Mean maximum and minimum values of psychrotrophic counts were, respectively, $6.5 \times 10^7$/g, $2.2 \times 10^8$/g and $7.3 \times 10^6$/g.

**TABLE 1.** Population ranges and number and percentages for a total of 42 soudjouk samples falling in each range.

<table>
<thead>
<tr>
<th>Type of Bacteria</th>
<th>Population range and sample number % falling in ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-</td>
</tr>
<tr>
<td>APC (37°C)</td>
<td>10</td>
</tr>
<tr>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>APC (25°C)</td>
<td>3</td>
</tr>
<tr>
<td>(%)</td>
<td>(7.1)</td>
</tr>
<tr>
<td>Psychrotrophic</td>
<td>1</td>
</tr>
<tr>
<td>(%)</td>
<td>(2.3)</td>
</tr>
<tr>
<td>Coliform</td>
<td>2</td>
</tr>
<tr>
<td>(4.7)</td>
<td>(7.1)</td>
</tr>
<tr>
<td>E. coli</td>
<td>9</td>
</tr>
<tr>
<td>(21.4)</td>
<td>(4.7)</td>
</tr>
<tr>
<td>S. aureus</td>
<td>5</td>
</tr>
<tr>
<td>(11.9)</td>
<td>(7.1)</td>
</tr>
<tr>
<td>Salmonella</td>
<td>-</td>
</tr>
<tr>
<td>Shigella</td>
<td>2</td>
</tr>
<tr>
<td>(4.7)</td>
<td></td>
</tr>
</tbody>
</table>

aAPC: Aerobic plate count.
Samples generally gave very high coliform, *E. coli* and *S. aureus* counts (Table 1) when compared to other meat products. In 39 (95%) of the total of 42 samples, the coliform groups of bacteria were found. In 37 (88%) of the 42 samples, *S. aureus* was found and 33 (79%) of the 42 samples contained *E. coli*. Approximately 62% of the samples had an excess of $10^4$ total coliforms/g and 36% higher than $10^5$ and 14% higher than $10^6$ coliforms/g. Mean, maximum and minimum values of coliforms were $7.7 \times 10^4$/g, $2.0 \times 10^5$/g and $4.5 \times 10^4$/g, respectively. Total APC, at 37 and 25°C, psychrotrophic and coliform levels of the soudjouk samples were slightly higher than those of ground beef samples sold in Erzurum markets (17), whereas *E. coli* counts of soudjouk samples were notably lower than of ground beef.

*E. coli* distribution ranged from 0 to $1.3 \times 10^5$ and resulted in a $4.6 \times 10^4$/g mean value. The nine samples which contained no detectable *E. coli* were very dry and also had a very high fat percentage (over 50%). As seen from the data, approximately 62% of the samples contained more than $10^3$ *E. coli*/g, and 38% more than $10^4$ and 9% more than $10^5$ *E. coli*/g.

Mean, maximum and minimum values of coagulase-positive *S. aureus* counts were, respectively, $2.6 \times 10^4$, $1.5 \times 10^5$ and $1.1 \times 10^5$/g. Only 40% of the samples had less than 1000 *S. aureus*/g.

Figure 1 gives the average APC counts and other enumerated bacteria in products of 8 manufacturers for each month. APC at 37 and 25°C and psychrotrophic counts generally decreased from October to December or January and then APC at 25°C and psychrotrophic counts increased slightly. This decrease can be explained by the decreasing winter temperature during processing and marketing and during the sampling period. Coliform counts fluctuated and *E. coli* and *S. aureus* counts did not show noticeable trends during the 5-month sampling period.

During this 5-month sampling, there were no *Salmonella* spp. detected in the samples. Two of the 42 samples yielded *Shigella* spp.; one was in October and the other in January. The one determined in October was *Shigella boydii*. The species of the 2nd positive sample was not determined because it gave a positive agglutination test with polyvalent antiserum, and did not give any agglutination with the monovalent antiseraums.

Figures 2 and 3 give the bacterial distribution in the eight manufacturers' soudjouk samples. Total counts and distribution of APC at 37°C/48 h incubation (Fig. 2) and psychrotrophic counts (Fig. 3) are illustrated. As seen from data in the figures, there are no large differences among the manufacturers. However, different samples of the same manufacturer often showed great variations depending on the different sampling times. This could indicate a lack of standardization from the beginning of the processing to the end of the marketing.

Figures 4 and 5 give the total coliform and *E. coli* counts of the eight different manufacturers' soudjouk. These counts may be used as a good indication of sanitation. The data in Fig. 5 generally indicate the soudjouk samples of each manufacturer showed large variations in the *E. coli* counts at different sampling periods. Variations among the different manufacturers were also very noticeable. The soudjouk samples of manufacturer P, which is the State Meat Plant, and the samples of O and M companies, which are large processors gave significantly (P<0.05 and/or P<0.01) lower *E. coli* counts than those of other processors. The lower *E. coli* counts of the soudjouks of the State Meat Plant can be explained by the fair sanitary conditions, hygienic rules, and generally controlled processing and ripening practices as well as use of limited refrigeration during the marketing process.
Soudjouk samples were processed by the small butcher shop owners under their very primitive conditions and are collectively coded as R. They generally use their small mincers as the stuffing machines, brine cured intestines as the casings and their stores as the ripening rooms. Soudjouk samples coded with the letter S, were collected from sections of the city with lower income and social standards and the origins of these soudjouks were not known. These were collectively coded as S.

Figure 6 gives the counts and distribution of the coagulase-positive S. aureus in sausages of the different manufacturers. As for E. coli counts, there are great variations among samples of the different manufacturers and also among the samples of the same manufacturer. Again, similar patterns to the E. coli counts are noted with samples from the P and O manufacturers, indicating considerably (P<0.05) lower S. aureus counts. Samples of R gave significantly (P<0.01) higher S. aureus counts than the other samples. It should be remembered that samples R represent soudjouks processed by the small butcher shop owners, and that samples P and O were produced by the State Meat Plant and a large processor, respectively.

CONCLUSIONS

In conclusion, all enumerated bacteria levels of the soudjouk samples were very high compared to some other common meat products' level. It should be noted that the soudjouk samples of the State Meat Plant and one other
large processor had lower bacteria levels than products of the small and less well known manufacturers. This is probably the result of increased sanitary controls and adopting of processing technology. In Turkey, soudjouk production should be standardized with particular attention paid to sanitation. To develop appropriate standards for bacteriological quality of soudjouks, and to develop appropriate processing procedures, additional work is needed in this and other sections of Turkey. Bacteriological standards for marketed soudjouks should be developed as soon as possible. These standards should be adapted to the manufacture and marketing of soudjouk for the benefit of public health since soudjouk is consumed unfried or slightly fried and also for economical consideration.

REFERENCES


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