**A Research Note**

**Microbiological Quality of Tehineh Manufactured in Saudi Arabia**

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**ABSTRACT**

Tehineh is a product obtained by the milling of dehulled and roasted white sesame seeds. A total of 50 tehineh samples was collected from ten processing plants in Saudi Arabia. These samples were examined by standard procedures for aerobic plate counts (APC) and counts of coliforms, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens*, molds and yeasts and detection of salmonellae. APC of tehineh ranged from 20 to 170,000 CFU/g. The counts for coliforms, *S. aureus*, *B. cereus*, *C. perfringens*, and molds and yeasts ranged from <10 to 300, <10 to 400, <10 to 250, <10 to 100, <10 to 120 and <10 to 50 CFU/g, respectively. Two out of ten tehineh plants (20%) were positive for four Salmonella serotypes. Four Salmonella serotypes recovered were *Salmonella hadar*, *Salmonella agona*, *Salmonella einsbuettel* and *Salmonella ubrecht*, with *S. hadar* being the most predominant. The results of this investigation indicate that foodborne pathogens present in tehineh may constitute a potential public health hazard.

Tehineh is an oily paste-like product obtained by the milling of dehulled roasted sesame seeds. Sesame is grown primarily in tropical and subtropical areas of the world and lately has been adapted to semi-arid regions. The world yearly production for the year 1982 was estimated to be 1,870,000 tons, with India, China and Sudan being the major world producers (4). Sesame seeds contain about 50% oil, which is highly stable, and about 25% protein which is rich in the sulfur-containing amino acids, methionine and cystine. The dehulled sesame seeds are used in bread and in other different types of foods in various parts of the world (7). However, in the Middle East, dehulled sesame seeds are mainly used in the production of tehineh (thick oily paste) and halaweh (Halva), a sweet made from tehineh, sugar, citric acid and *Saponaria officinalis* root extract.

In Saudi Arabia, tehineh is produced in ten commercial plants, with a total annual production in 1984 of 15,500 tons. Some plants are equipped with the most modern production lines and are completely automatic, whereas others are still using the old primitive method of manufacturing with very little hygienic concept. All the sesame seed used in the production of tehineh and halawa in Saudi Arabia is imported from India, Sudan and Ethiopia.

Tehineh is commonly used in Middle East countries to prepare many popular dishes and other local food such as hommus tehineh, prepared by mixing tehineh with chick peas and baba gannouj, prepared by mixing tehineh with eggplant. Tehineh is also used as a major constituent (50%) in halawa and other sweets.

Information on the chemical composition of tehineh is scarce. Pellet and Shadarevian (10) reported on the chemical composition of tehineh from Lebanon, and recently, Sawaya et al. (11) reported on the chemical composition and nutritional value of tehineh in Saudi Arabia. Their results indicated a high fat percentage (58.9%), with oleic and linoleic acid constituting most of the fatty acids. Also, tehineh contained a relatively high protein content (24.7%), low percentage of crude fiber (2.3%) and moisture (<1%), and a substantial amount of ash (3.0%). However, data on the microbiological quality of tehineh is lacking. The objectives of this investigation were to assess the microbiological quality of tehineh produced in Saudi Arabia and the possible public health hazards with its consumption.

**MATERIALS AND METHODS**

Manufacturing of tehineh

Tehineh is manufactured in specialized factories in various parts of Saudi Arabia. The methods used vary from one factory to the other; however, the basic principles followed for the preparation of tehineh are the same. Briefly, the sesame seeds are cleaned, sieved and dehulled, either by soaking in water and then passing through a peeler or by steam injection and hot air blowing. The seeds are dried and roasted (90 to 100°C) for a few minutes. The roasted sesame seeds are then ground...
either by stone mills or by high speed automatic mills to a viscous oily paste which is then filled into plastic containers of various sizes and marketed as tehineh.

Sample collection

This study was done during the period of 1982 to 1983. A total of ten plants were visited in three provinces (central, western and eastern) of Saudi Arabia. Five tehineh samples were collected from each plant. The sample size varied from 0.5 to 2.5 kg. All samples collected were packed in plastic containers, held at room temperature and analyzed within 48 h.

Sample preparation

Samples of tehineh were thoroughly mixed and a 25-g portion of each sample with 225 ml of sterilized 0.1% peptone were added to a sterilized Waring blender container. The samples were homogenized for 3 min at low speed. Serial dilutions were made from $10^1$ to $10^6$ and the samples were analyzed for aerobic plate count (APC), coliforms, Staphylococcus aureus, Clostridium perfringens, Bacillus cereus, Salmonella spp., and yeasts and molds (1,5). All bacteriological media used were formulated by Difco unless otherwise specified.

Bacteriological analyses

APCs were done on plate count agar and incubated at 32°C for 48 h. Violet red bile agar (VRBA) with overlay was used for the enumeration of coliforms, and the plates were incubated at 35°C for 24 h. All purplish-red colonies surrounded by a red zone of precipitated bile acid were counted as coliforms (5). Baird-Parker agar plates were used for counting S. aureus, and the plates were incubated at 35°C for 48 h. Selected black colonies were tested for coagulase activity by using coagulase plasma EDTA. C. perfringens analyses were done in duplicate using Shahidi-Ferguson perfringens (SFP) agar base supplemented with egg yolk enrichment and D-cycloserine at a final pH of 7.6 (12). The plates were incubated anaerobically at 35°C for 24 h in BBL jars with a GasPak envelope (BBL Microbiology Systems) in the jar. Black colonies typical of C. perfringens were transferred to a tube of fluid thioglycolate, incubated at 35°C for 24 h and then in a water bath at 46°C for 4 h. C. perfringens cultures were confirmed on the basis of morphology, biochemical reactions and lecithinase production (5). The phenol red-egg yolk polymyxin (MYP) medium of Mossel et al. (8) was used to enumerate B. cereus. Typical colonies surrounded by a halo of dense precipitate (lecithinase activity) with a distinct violet-red background were counted. Colonies typical of B. cereus were isolated and confirmed by determining reduction of nitrate, acetyl methyl carbinol production, aerobic and anaerobic utilization of glucose, sucrose, glycerol, salicin, and hydrolysis of gelatin (6).

Salmonella spp. were detected by preenrichment of tehineh in lactose broth (9) followed by the scheme outlined in the Bacteriological Analytical Manual (5). Typical Salmonella colonies were picked and tested for biochemical characteristics using the tests described by Edwards and Ewing (3).

Grouping and serotyping of salmonellae

Following biochemical confirmation, the fresh cultures were serogrouped using Salmonella polyvalent and specific somatic antisera (BBL Microbiology Systems). Stock cultures of the Salmonella isolates were then forwarded to the Institute of Medical and Veterinary Sciences, Adelaide, Australia, for serotyping.

RESULTS AND DISCUSSION

The distribution of bacteriological counts obtained from tehineh samples from ten tehineh plants in Saudi Arabia is summarized in Table 1. The APC for tehineh ranged from 20 to $1.7 \times 10^5$ CFU/g, with a mean of $2.0 \times 10^4$ CFU/g. This is considerably higher than the counts reported by Brito (2) in sesame products, which averaged $3.8 \times 10^3$ CFU/g. However, the mean counts of eight plant samples was low, 443 CFU/g, with the exception of samples from two plants with APCs of $2.3 \times 10^4$ and $1.7 \times 10^5$ CFU/g, respectively. The high APC may have been due to mishandling of sesame seeds after roasting and/or contamination of tehineh (sesame butter) during filling by hand or machine.

Coliform counts in the ten tehineh plants ranged from $<10$ to 300 CFU/g, with an average of 49 CFU/g. There was a correlation between high coliform counts and the presence of salmonellae in the plants (Table 1).

### TABLE 1. Microbiological analyses of 50 tehineh samples in ten plants in Saudi Arabia.  

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>APC (CFU/g)</th>
<th>Coliform</th>
<th>S. aureus</th>
<th>C. perfringens</th>
<th>B. cereus</th>
<th>Yeast</th>
<th>Mold</th>
<th>Salmonella</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>500*</td>
<td>100</td>
<td>400</td>
<td>$&lt;10$</td>
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<td>50</td>
<td>$+^b$</td>
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<tr>
<td>2</td>
<td>50</td>
<td>$&lt;10$</td>
<td>70</td>
<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>10</td>
<td>120</td>
<td>$-^c$</td>
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<td>3</td>
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<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>$&lt;10$</td>
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<td>20</td>
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<tr>
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<td>$&lt;10$</td>
<td>$&lt;10$</td>
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<td>100</td>
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<td>10</td>
<td>$+$</td>
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<td>6</td>
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<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>30</td>
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<td>10</td>
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<tr>
<td>9</td>
<td>170,000</td>
<td>10</td>
<td>10</td>
<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>20</td>
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<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>20</td>
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</tr>
</tbody>
</table>

*Each value is the calculated mean of duplicate replication of five samples.

$b^+$, positive.

$^c-$, negative.
The tehineh produced in most of the plants (70%) contained less than 10 coagulase-positive S. aureus/g. However, the product from one plant averaged 400 S. aureus/g. The average S. aureus count in the ten tehineh plants was 56 CFU/g. The C. perfringens counts in most of the plants (90%) were less than 10 CFU/g, with counts from samples of one plant at 100 CFU/g. The B. cereus count was also very low, <10 CFU/g, in samples from 8 of 10 plants. The yeast and mold counts were very low, 10 to 120 CFU/g, as compared with the results of Brito (2) who reported them to be in the range of 3.3 $\times$ 10³ to 6.5 $\times$ 10³ CFU/g. Salmonellae were isolated from samples from two of 10 plants. Both of these plants were old and the workers were not following good manufacturing practices.

Four Salmonella serotypes were isolated, including Salmonella hadar, Salmonella agona, Salmonella einsbuettel and Salmonella ubrecht. Of the four serotypes isolated, S. hadar was the most predominant. The presence of Salmonella is a serious public health problem because tehineh is used in the preparation of certain foods, i.e., homus tehineh, which are commonly used as a dip without further heat treatment.

REFERENCES