

# MICROBIAL BEHAVIOR OF FRESH SAUSAGES CONTAINING SHEEP OR GOAT MEAT

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## SUMMARY

A study to evaluate the bacterial content of fresh sausages manufactured with pork fat and sheep or goat meat and stored for 30 days at 5 °C was conducted. Meats were used to formulate sausages containing two levels of pork fat (16% and 27%) and two sodium nitrite concentrations (0 ppm and 100 ppm). Sausages stuffed into natural casings and packaged into nylon/polyethylene film with vacuum (76 cm Hg) or without vacuum. Mesophiles, psychrophiles, coliforms, *S. aureus* and bacteria from genera *Salmonella*, *Clostridium* and *Yersinia* were searched for on raw meat and on sausages with 0, 15 and 30 days storage.

Results indicated initial levels of mesophilic bacteria of about  $10^4$  CFU/g in sheep and goat raw meat and  $10^2$  MPN/g coliforms in goat raw meat. After 15 days storage sausages packaged without vacuum had increased mesophiles, coliforms and *S. aureus* bacteria to levels of  $10^5$  CFU/g,  $10^2$  MPN/g and  $10^2$  CFU/g respectively, and psychrophiles to  $10^6$  to  $10^7$  CFU/g.

After 30 days storage without vacuum sheep sausages presented abnoxious odours and faded colours and goat sausages reached levels of about  $10^7$  CFU/g,  $10^2$  MPN/g,  $10^7$  CFU/g and  $10^3$  CFU/g for mesophilic, coliforms psychrophiles and *S. aureus*, respectively.

Storage with vacuum packaging kept levels of bacteria in both sheep and goat sausages around  $10^5$  CFU/g,  $10^2$  MPN/g,  $10^5$  CFU/g and 10 CFU/g for mesophiles, coliforms, psychrophiles and *S. aureus*, respectively, to the end of the 30 days storage period.

Sausage fat content seemed not to affect the growth of bacteria in this study. Although no organisms from the genera *Salmonella*, *Clostridium* or *Yersinia* were found in this experiment sodium nitrite (100 ppm) did not inhibit *S. aureus* growth in sheep or goat sausages.

## INTRODUCTION

For many years sheeps and goats have been reared in Northeast Brasil as an extensive farming activity mainly for milk and skin production and with little attention to the eating quality of meat. For this reason mutton and goat meats from older animals are considered somehow objectionable due to strong flavour, poor texture and eventually to the presence of obnoxious odours.

The manufacturing of sausages containing pork fat and lean meat from lamb and goat has been considered an alternative way to make available meat from older animals to a larger segment of the local population. Therefore it is important that, other than the organoleptic characteristics of the product, the microbiological condition of these types of sausages can be assessed.

The present study was designed to evaluate the presence of pathogenic and putrefactive bacteria on fresh goat and sheep sausages stored under refrigeration for a 30 days period.

## MATERIAL AND METHODS

Eight types of sausages were formulated with sheep or goat meat as to contain 16% or 27% pork fat (A and B), 0 ppm or 100 ppm sodium nitrite (C and D), cure and spices. The meat used in this trial was a composite of the lean partes of recently slaughtered animals.

Sausages were packaged under vacuum ( 76 cm Hg) or without vacuum and stored for 30 days at 5 °C. Fresh sausages were analysed for proximal composition soon after preparation. Microbial examination was performed on the lean meat and on sausages after 0, 15 and 30 days storage ( $T_0$ ,  $T_1$ ,  $T_2$ ).

Moisture and ashes were determined according to the procedure described by INSTITUTO ADOLFO LUTZ (1985), fat by the KONIECKO (1979) method, and protein according to the A.O.A.C. (1980) technique.

Twenty five grams of lean meat or sausage were blended with 225 ml buffered saline for two minutes to prepare a  $10^{-1}$  dilution, according to I.C.M.S.F. (1978). Further dilutions of this were used for the following analysis: mesophilic and psychrophilic organisms according to LANARA (1981), coliforms, S. aureus and Salmonella according to I.C.M.S.F. (1978), sulfur reducing Clostridia according to FAE (1985) and Y. enterocolitica by the methods of WARNEKEN et al. (1987) and RUGAI et al. (1968). All results were expressed as colony forming units per gram sample (CFU/g) except for coliforms which were expressed as most probably number of cells per gram sample (MPN/g).

## RESULTS AND DISCUSSION

Results in Table 1 indicate that goat meat sausages had slightly higher values of fat (25% and 15%, average) than sheep sausages (23% and 13%, average). This is probably due to a higher content of fat in goat lean meat than in sheep lean meat. Moisture content tended to vary in the sausages accordingly to the fat content, as expected.

Sheep sausages. Lean sheep meat indicated a relatively high initial contamination with mesophilic bacteria ( $4.4 \times 10^4$  CFU/g), low levels of psychrophiles (75 CFU/g) and absence of coliforms and S. aureus (Table 2). After sausage preparation and before the storing period ( $T_0$ ) however, the presence of faecal coliforms and S. aureus were detected in the product (Table 2) indicating contamination during the handling and blending procedures of sausage manufacturing. Storing of the sausage without vacuum packaging allowed the microbial examination just to the 15th day of storage (Table 2) when they developed objectionable colours and odours probably due to the proliferation of mesophilic ( $10^3$  to  $10^7$  CFU/g) and/or psychrophilic ( $10^5$  to  $10^7$  CFU/g) bacteria. Similar levels of microbial growth were reached by vacuum packaged sausages after 30 days of storage (Table 2). Sodium nitrite (sausages C and D) showed limited effect on S. aureus growth which reached levels of  $10^2$  CFC/g in the sausages packaged without vacuum and 10 CF/g in the ones with vacuum (Table 2).

Goat sausages. Lean goat meat indicated relatively high initial levels of both mesophilic and psychrophilic bacteria (about  $10^4$  CFU/g, Table 3) and also presence of coliform bacteria (28 MPN/g). After 30 days storage sausages packaged without vacuum (Table 3) reached levels of mesophilic and/or psychrophilic bacteria of  $10^7$  CFU/g, approximately. Vacuum packaging, however, kept the level of these bacteria in the range of  $10^5$  CFU/g to the end of the 30 days storage period (Table 3). Coliform bacteria in sausages packaged with vacuum or without vacuum kept relatively low (10 to 100 MPN/g) during the storage period (Table 3). S. aureus contamination was detected in the sausages packaged without vacuum (Table 3) soon after manufacture ( $T_0$ ). The level of this microorganism increased throughout the 30 days storage period to levels of about  $10^3$  CFU/g. S. aureus was not detected in the sausages stored with vacuum.

The presence of bacteria from the genera Salmonella, Clostridium or Yersinia was not detected in any type of sausage analysed in this study.

## CONCLUSION

Sausages containing goat meat were slightly higher in fat content than those containing sheep meat. However, this difference did not affect the level of microorganisms in the products during the refrigerated (5 °C) 30 days storage period.

Raw meat from sheep and goat used for sausages manufacture had rather high levels of mesophilic and/or psychrophilic bacteria.

The presence of faecal coliforms and S. aureus in the sausages soon after manufacture suggests that ingredients as well as handling procedures have to be carefully checked at the processing room level.

Vacuum packaging produced sausages with lower levels of microorganisms than those packaged without vacuum.

Sodium nitrite (100 ppm) did not inhibit *S. aureus* growth in sausages contaminated with this microorganisms.

Bacteria belonging to genera *Salmonella*, *Clostridium* or *Yersinia* were not detected in the sausages analysed in this study.

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Table 1. - Proximate composition (%) of fresh coarse sausages formulated using lamb or goat meat and pork fat. Mean values and standard deviation (n=8).

| Sausage   | Composition (%) |            |            |           |
|-----------|-----------------|------------|------------|-----------|
|           | Moisture        | Protein    | Fat        | Ash       |
| Lamb Meat |                 |            |            |           |
| A         | 63.1 ± 2.8      | 16.8 ± 0.6 | 16.0 ± 2.8 | 2.3 ± 0.2 |
| B         | 55.2 ± 3.7      | 13.7 ± 2.4 | 26.6 ± 0.3 | 2.7 ± 0.0 |
| C         | 62.3 ± 2.1      | 16.0 ± 1.1 | 14.7 ± 2.2 | 2.5 ± 0.1 |
| D         | 56.4 ± 0.1      | 14.1 ± 1.8 | 24.9 ± 0.4 | 2.5 ± 0.1 |
| Goat meat |                 |            |            |           |
| A         | 65.5 ± 0.7      | 14.8 ± 2.1 | 13.3 ± 0.5 | 2.7 ± 0.1 |
| B         | 58.0 ± 1.5      | 12.5 ± 1.6 | 24.4 ± 0.5 | 2.5 ± 0.3 |
| C         | 66.5 ± 0.2      | 15.5 ± 1.4 | 13.4 ± 1.4 | 2.6 ± 0.1 |
| D         | 59.1 ± 1.0      | 14.0 ± 2.7 | 21.3 ± 0.9 | 2.7 ± 0.1 |

- A = low fat/No nitrite  
B = high fat/No nitrite  
C = low fat/nitrite  
D = high fat/nitrite

Table 2. - Microbial counts in raw sheep meat and in sausages manufactured with sheep meat and stored at 5 °C for 30 days.

|                  |                | Packaging without vacuum |                    |                    |                           | Packaging with vacuum |                    |                    |                           |
|------------------|----------------|--------------------------|--------------------|--------------------|---------------------------|-----------------------|--------------------|--------------------|---------------------------|
| Analysed samples |                | Mesophil.<br>CFU/g       | Coliforms<br>NMP/g | Psycroph.<br>CFU/g | <u>S. aureus</u><br>CFU/g | Mesophil.<br>CFU/g    | Coliforms<br>NMP/g | Psycroph.<br>CFU/g | <u>S. aureus</u><br>CFU/g |
| Raw Meat         |                | $4.4 \times 10^4$        | absence            | $7.5 \times 10^1$  | absence                   | $4.4 \times 10^4$     | absence            | $7.5 \times 10^1$  | absence                   |
| A                | T <sub>0</sub> | $7.0 \times 10^4$        | $2.3 \times 10^1$  | $6.0 \times 10^3$  | $1.0 \times 10^1$         | $1.1 \times 10^5$     | $4.3 \times 10^1$  | $1.4 \times 10^5$  | absence                   |
|                  | T <sub>1</sub> | $3.0 \times 10^5$        | $3.0 \times 10^2$  | $3.0 \times 10^5$  | $1.0 \times 10^1$         | $1.5 \times 10^5$     | $1.1 \times 10^1$  | $1.5 \times 10^5$  | $1.1 \times 10^1$         |
|                  | T <sub>2</sub> | ---                      | ---                | ---                | ---                       | $2.4 \times 10^5$     | $4.3 \times 10^1$  | $2.4 \times 10^5$  | $7.0 \times 10^1$         |
| B                | T <sub>0</sub> | $1.0 \times 10^5$        | $2.1 \times 10^1$  | $8.0 \times 10^3$  | absence                   | $3.0 \times 10^4$     | $4.3 \times 10^1$  | $3.0 \times 10^3$  | absence                   |
|                  | T <sub>1</sub> | $9.0 \times 10^3$        | $2.4 \times 10^2$  | $1.0 \times 10^5$  | absence                   | $3.4 \times 10^5$     | $2.4 \times 10^2$  | $2.5 \times 10^5$  | $1.1 \times 10^1$         |
|                  | T <sub>2</sub> | ---                      | ---                | ---                | ---                       | $3.0 \times 10^7$     | $4.6 \times 10^2$  | $3.0 \times 10^7$  | $1.7 \times 10^1$         |
| C                | T <sub>0</sub> | $1.0 \times 10^3$        | $9.3 \times 10^1$  | $1.0 \times 10^3$  | absence                   | $1.5 \times 10^4$     | $2.4 \times 10^2$  | $1.5 \times 10^4$  | absence                   |
|                  | T <sub>1</sub> | $2.2 \times 10^7$        | $3.0 \times 10^2$  | $2.0 \times 10^7$  | $1.0 \times 10^2$         | $3.4 \times 10^4$     | $9.3 \times 10^1$  | $3.0 \times 10^4$  | $1.0 \times 10^1$         |
|                  | T <sub>2</sub> | ---                      | ---                | ---                | ---                       | $2.5 \times 10^5$     | $9.8 \times 10^1$  | $1.5 \times 10^5$  | $1.7 \times 10^1$         |
| D                | T <sub>0</sub> | $1.0 \times 10^3$        | $2.4 \times 10^2$  | $1.0 \times 10^3$  | absence                   | $2.3 \times 10^4$     | $2.4 \times 10^2$  | $4.0 \times 10^4$  | absence                   |
|                  | T <sub>1</sub> | $1.0 \times 10^4$        | $2.4 \times 10^2$  | $2.0 \times 10^6$  | $1.0 \times 10^2$         | $1.8 \times 10^2$     | $3.0 \times 10^1$  | $1.0 \times 10^5$  | absence                   |
|                  | T <sub>2</sub> | ---                      | ---                | ---                | ---                       | $1.4 \times 10^5$     | $9.3 \times 10^1$  | $1.1 \times 10^5$  | $3.4 \times 10^1$         |

T<sub>0</sub> = 0 day storage; T<sub>1</sub> = 15 days storage; T<sub>2</sub> = 30 days storage

TABLE 3.- Microbial counts in goat raw meat and in sausages manufactured with goat meat and stored at 5 °C for 30 days.

|                  |                | Packaging without vacuum |                    |                    |                           | Packaging with vacuum |                    |                    |                           |
|------------------|----------------|--------------------------|--------------------|--------------------|---------------------------|-----------------------|--------------------|--------------------|---------------------------|
| Analysed samples |                | Mesophil.<br>CFU/g       | Coliforms<br>NMP/g | Psycroph.<br>CFU/g | <u>S. aureus</u><br>CFU/g | Mesophil.<br>CFU/g    | Coliforms<br>NMP/g | Psycroph.<br>CFU/g | <u>S. aureus</u><br>CFU/g |
| Raw Meat         |                | $5.0 \times 10^4$        | $2.8 \times 10^1$  | $1.0 \times 10^4$  | absence                   | $5.0 \times 10^4$     | $2.8 \times 10^1$  | ND                 | absence                   |
| A                | T <sub>0</sub> | $5.0 \times 10^4$        | $2.1 \times 10^1$  | $2.8 \times 10^3$  | absence                   | $4.0 \times 10^4$     | $2.1 \times 10^1$  | ND                 | absence                   |
|                  | T <sub>1</sub> | $8.0 \times 10^5$        | $2.4 \times 10^2$  | $4.0 \times 10^5$  | $2.0 \times 10^2$         | $3.0 \times 10^5$     | $2.4 \times 10^2$  | $2.0 \times 10^4$  | absence                   |
|                  | T <sub>2</sub> | $3.0 \times 10^7$        | $4.6 \times 10^2$  | $3.0 \times 10^7$  | $2.0 \times 10^3$         | $3.0 \times 10^5$     | $9.3 \times 10^1$  | $3.0 \times 10^4$  | absence                   |
| B                | T <sub>0</sub> | $4.0 \times 10^4$        | $2.3 \times 10^1$  | $1.0 \times 10^1$  | absence                   | $1.3 \times 10^5$     | $2.3 \times 10^1$  | ND                 | absence                   |
|                  | T <sub>1</sub> | $3.0 \times 10^5$        | $3.9 \times 10^2$  | $3.0 \times 10^5$  | $1.0 \times 10^2$         | $2.4 \times 10^5$     | $1.2 \times 10^2$  | $3.0 \times 10^3$  | absence                   |
|                  | T <sub>2</sub> | $7.0 \times 10^7$        | $7.1 \times 10^2$  | $2.0 \times 10^7$  | $1.8 \times 10^3$         | $3.0 \times 10^5$     | $2.1 \times 10^2$  | $3.0 \times 10^5$  | absence                   |
| C                | T <sub>0</sub> | $3.0 \times 10^3$        | $4.6 \times 10^2$  | $2.4 \times 10^4$  | absence                   | $6.0 \times 10^4$     | $6.4 \times 10^2$  | ND                 | absence                   |
|                  | T <sub>1</sub> | $1.0 \times 10^7$        | $2.4 \times 10^2$  | $1.5 \times 10^7$  | $1.0 \times 10^3$         | $1.0 \times 10^5$     | $7.5 \times 10^1$  | $1.5 \times 10^3$  | absence                   |
|                  | T <sub>2</sub> | $3.0 \times 10^7$        | $4.6 \times 10^2$  | $3.0 \times 10^7$  | $1.5 \times 10^3$         | $2.0 \times 10^5$     | $1.2 \times 10^2$  | $2.0 \times 10^4$  | absence                   |
| D                | T <sub>0</sub> | $4.0 \times 10^3$        | $2.8 \times 10^1$  | $1.5 \times 10^3$  | absence                   | $2.0 \times 10^5$     | $2.3 \times 10^1$  | ND                 | absence                   |
|                  | T <sub>1</sub> | $1.0 \times 10^5$        | $4.6 \times 10^2$  | $2.4 \times 10^4$  | $1.5 \times 10^2$         | $3.0 \times 10^5$     | $3.0 \times 10^1$  | $1.0 \times 10^4$  | absence                   |
|                  | T <sub>2</sub> | $1.0 \times 10^7$        | $4.6 \times 10^2$  | $3.0 \times 10^7$  | $1.0 \times 10^3$         | $3.0 \times 10^5$     | $4.3 \times 10^1$  | $1.6 \times 10^5$  | absence                   |

T<sub>0</sub> = 0 day storage; T<sub>1</sub> = 15 days storage; T<sub>2</sub> = 30 days storage. ND = not determined.