

IDENTIFICATION AND QUANTIFICATION OF CONTAMINATION SOURCES DURING THE MANUFACTURE OF MINCED BEEF IN FRANCE

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INTRODUCTION

The hygienic quality of minced beef depends on many factors including both the raw material and all meat processing conditions throughout the steps in the production process. Controlling the hygienic quality of this minced meat therefore involves knowing exactly how each of these factors affects the contamination of the finished products (set of problems occurring within the context of implementing the HACCP - Hazard Analysis Control Critical Point - process).

Previous research (Cartier, 1993) showed that the bacteriological quality of the raw material, i.e. the surface contamination of the fore quarters, had a major effect on that of the hamburgers. The fore quarter contamination level, in fact, accounted for nearly 60 to 70% (depending on the particular flora: Total Viable Counts (TVC), Pseudomonadaceae (PS) and Enterobacteriaceae (Eb)) that of the hamburgers. Contamination introduced by all the steps in the process seems therefore to be the minority (about 30% of the contamination of the finished product), but not negligible.

The purpose of this study is to identify where in the production process this part of the contamination occurs.

MATERIALS AND METHODS

The principle of the study consists of tackling under real production conditions all the data concerning the criteria characterising the process from the hygiene point of view according to a notation grid (Cartier et al, 1995) and the finished product contamination measurements.

The follow-up was carried out on a 15% fat pure beef hamburger production process.

Follow-up unit

The follow-up unit is one production of minced meat, i.e. the quantity of minced meat corresponding to a mixing mill (between 300 and 800 kg depending on the company).

To obtain maximum variability of production conditions as well as good representativeness, 66 follow-ups were carried out, distributed amongst 11 industrial companies.

Bacteriological checks performed:

On a batch of fore quarters corresponding to a production of minced meat at 15% fat: 6 are chosen at random (Cartier, 1990) and sampled at the surface at 3 areas: neck, shoulder, extremity of fore rib (Cartier, 1991). These 3 samples taken on each fore quarter are grouped together and frozen.

On the hamburgers: leaving the former, 5 cling-filmed food trays are sampled at random from the batch and then frozen.

For each sample taken, the Total Viable Counts (TVC), Pseudomonadaceae (PS) and Enterobacteriaceae (Eb) are counted.

Notings down of the hygiene evaluation grid:

This grid is composed of a multitude of potentially polluting criteria, of 2 types: either qualitative criteria, based on visual observation and structured in 3 levels (room, personnel, operation-equipment), or measured quantitative variables (temperature, hygrometry, time, etc.) (Cartier et al, 1995).

It concerns the 5 major steps in the process (storage of the fore quarters in refrigerator room, cutting, storage of the cut meat in refrigerator room, mincing and forming). For each step, all the criteria are recorded during batch follow-up.

A total of nearly 455 criteria are recorded per production run, with 368 qualitative variables and 87 quantitative variables.

Processing the data:

The data were analysed with SAS (1988) as follows:

We first of all studied by linear regression, the relationship between contamination of the fore quarters and that of the hamburgers. The prediction equation resulting from this correlation allows us to establish for a given contamination of fore quarters the predicted contamination for the hamburgers, or the "theoretical hamburger contamination".

The difference between this "theoretical" contamination and the real (measured) hamburger contamination gives the part of contamination due to the production process. It is therefore on this criterion (called "bacteriological shift") that the analysis was based afterwards.

Concerning the qualitative criteria, the processing consisted of testing by variance analysis the mean values of this shift for each of the methods of criteria considered. Concerning the quantitative variables, we have studied by linear regression their relationship with this "bacteriological shift".

RESULTS

Contamination of the raw material has a significant effect on that of the hamburgers. The R^2 values for this relationship, globally lower than that obtained in 1993, vary from 0.35 to 0.60 depending on the flora on the productions followed. The strongest relationship concerns the Eb, and the lowest the TVC (see figure 1).

- Concerning the technical criteria measured, those that have a significant effect on increase of the bacterial load of the products are:
- the hygrometry of the refrigerator rooms used to store the fore quarters (see figure 2) and of the cutting room. It can be seen, in fact, that the number of bacteria increases greatly when the hygrometry exceeds about 85%.
 - incorporating CO₂ in the mince before forming (by the duration and its effect on lowering the meat temperature) (see figure 3).
 - the temperature difference between the refrigerator room used to store the fore quarters and the cutting room when it is above a particular value (about 3-4°C) tends to increase the "bacteriological shift".

Concerning the qualitative variables observed, of 286 tested 83, have a significant effect on product contamination. Taken globally, these criteria characterize quite precise risks in terms of product contamination. They are:

- the quality of the raw material processed just beforehand in cutting and in mincing (characterised by its origin and the slaughtering delay),
- the quality of the clothing worn by the personnel and the quality of wearing it throughout the process,
- the risks of contamination by germs independent of the process (non-specialised rooms, presence of unnecessary objects or equipment such as pallets or cardboard boxes, washing the equipment near the meat, etc.), risks nevertheless reduced through using cling film,
- the presence of *M. longus colli* in the load has a negative effect whereas mechanical trimming has a beneficial effect.

CONCLUSION

Finally, this study has brought to light information that is important in terms of explaining meat contamination during the mincing process transformation. We identified, in fact, in actual French mince production conditions, which parts of the process had a predominant effect on increasing the product bacterial load, whilst others, such as the cleaning-disinfecting frequencies, room temperatures or the times the batches were sent into the workshops, did not play a fundamental role, surely because of good control of this criteria of hygiene by companies. Concerning the implementation of the new hygiene approach (HACCP), it is vital to identify these factors to be able to analyse the risks involved in mince production.

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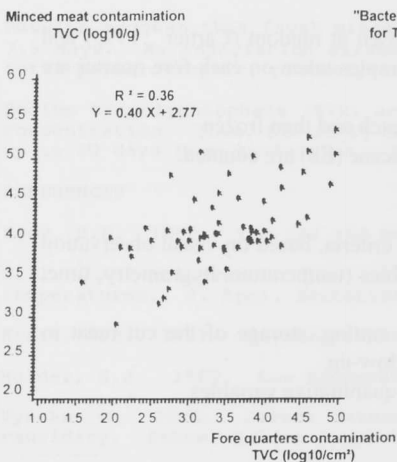


FIGURE 1 : Relationship between fore quarters and minced meat contamination for TVC

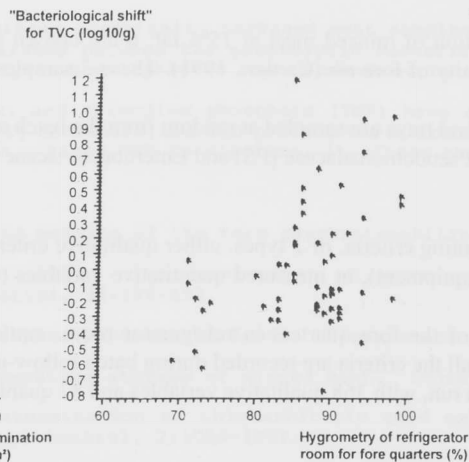


FIGURE 2 : Distribution of "bacteriological shifts" of the batches followed depending on the hygrometry of the refrigerator room for fore quarters

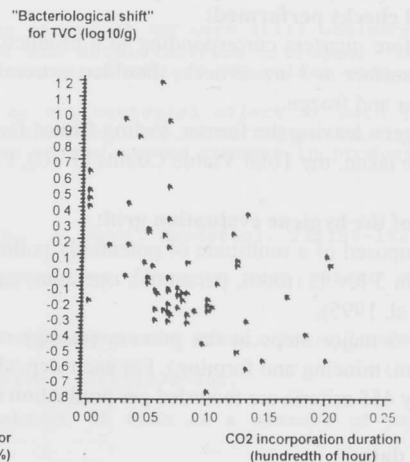


FIGURE 3 : Distribution of "bacteriological shifts" of the batches followed depending on the CO₂ incorporation duration