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Establishment of good hygiene practice-based microbiological criteria in food industries: Guidelines using an example for meat preparations

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ABSTRACT

In the context of the revision of the Codex Alimentarius Commission document "Principles for the Establishment and Application of Microbiological Criteria CAC/GL 21/1997", and in the scope of an FAO/WHO pilot project, seven examples on the application of microbiological criteria were developed to help illustrate the different contexts in which microbiological criteria might be used. This example describes a Good Hygiene Practice (GHP)-based microbiological criterion (MC), following the structure agreed by FAO/WHO. A GHP-based MC is a criterion used to monitor the production process of an establishment, to verify if it is functioning as expected and that GHPs are correctly implemented. For the development of this example, the authors chose raw meat preparations as the food commodity of interest, and *Escherichia coli* as an indicator of the effectiveness of GHPs during production. The sampling plan, including the values of *M, m, n,* and *c,* the analytical unit size, the analytical method, interpretation of results and corrective actions in case of non-conformance were based on empirical knowledge and on legislative rules in the countries of origin of the authors. This example is to illustrate the general approach which can be taken to establish such criteria and can be applied to other foods and for other microbiological contaminants.

1. Introduction

Practical examples for the establishment and application of microbiological criteria (MC) have been developed for the revision of the Codex Standard CAC/GL 21/1997 Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Food (CAC, 2013). The 43rd Session of the Codex Committee for Food Hygiene decided to develop, in the context of a pilot project established by FAO/WHO, seven examples on the establishment and application of MC to improve the understanding of such criteria and to explain the various contexts in which an MC may be used. This approach also facilitated greater participation by all countries in the Codex process of developing standards and guidelines. This example was developed by representatives of official institutions in Benin, Cameroon, Ghana and Panama under the mentorship of the European Commission, following the guidelines provided by FAO/WHO.

Good Hygiene Practices (GHPs) are practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain (Huss and Ryder, 2004). A GHP-based MC is a criterion set for a specific stage of the food production process which can be used by the food business operators and by competent authorities to monitor and verify that GHPs and Hazard Analysis Critical Control Point (HACCP) systems are performing as expected (CAC, 2003; EC, 2005a, 2005b; ICMSF, 2011).

For this example of a GHP-based MC, raw meat preparations were chosen, as these are relevant food commodities in the

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countries of origin of all authors and are produced under similar and comparable production processes.

The steps for establishing this GHP-based MC consisted of addressing the different elements or components of an MC (CAC, 2013):

- the purpose of the MC;
- who should establish the MC, who should apply it and at what specific point in the food chain will the MC be implemented;
- the target microorganism(s) of concern;
- the sampling plan, including the number of sampling units to be taken (n), the size of the analytical unit, the acceptance number (c) and the microbiological limits;
- method(s) of analysis;
- interpretation of results; and,
- corrective actions to be taken in cases of non-conformance with the MC.

Although this example was developed specifically for meat preparations, the same general approach could be followed for the development of GHP-based MC for other commodities, indicator microorganisms, and production processes.

2. Purpose

The purpose of a GHP-based MC is to verify the performance of hygienic practices in a production or manufacturing process. In this example, the MC is established and applied to verify that GHPs are correctly implemented and have been followed for the production of raw meat preparations. The end product is raw meat which has had foodstuffs, seasonings or additives added to it, and/or which has undergone a treatment that is insufficient to modify the cellular structure of the meat and does not cause the characteristics of the fresh meat to disappear (CAC, 2005).

3. Establishment and application of the criteria

The GHP-based MC could be established or developed by the food businesses operator or by the competent authority through legislation, guidance documents and/or other national or international standards (e.g. Codex standards or guidelines). The competent authority may consult the relevant stakeholders, including international or national associations, when developing the MC (Anonymous, 1984, 2001; EC, 2005b). A GHP-based MC should be implemented by the food businesses operators when developing their own food safety management system (e.g. GHP and HACCP plans). GHP-based MC should apply to industry (e.g. abattoirs, cutting plants, caterers, meat industry, producers of ready-to-eat food), but could also be adapted to other enterprises, for example those of a smaller scale (small- and medium-sized butchers, artisanal production) (EC, 2005a).

The GHP-based MC could also be used by the competent authority when assessing food business operators (Anonymous, 1984, 2001; EC, 2005b).

In this example, the GHP-based MC applies only to the manufacture of meat preparations, and should be implemented during the production process, preferably at the end of the production of the meat preparation, after packaging and before storage. Indicator tests of comminuted meats during distribution and retail display cannot be used to assess hygienic conditions during the time of manufacture, since other factors post-production (e.g., temperature abuse) may alter microbial populations (ICMSF, 2011). Therefore, this MC does not apply to meat preparations already placed on the market. Also, the MC does not apply for product that has been further transformed by a heat treatment.

4. Organism(s) of concern

When developing a GHP-based MC, a relevant hygiene indicator should be chosen. In this example, generic *Escherichia coli* was selected as an indicator of faecal contamination and adherence to GHPs during the manufacturing process (Altekruse et al., 2009; EC, 2005b; EFSA, 2011; EFSA, 2012).

Depending on the commodity, other hygiene indicator microorganisms (e.g.: aerobic colony count, Enterobacteriaceae, coliforms, coagulase-positive staphylococci, etc.) can also be useful as target organism for a GHP-based MC for on-going process control (EC, 2005a; ICMSF, 2011).

5. Sampling plan

The sampling plan selected for the MC will depend on the nature and purpose of the MC (CAC, 2013; ICMSF, 2002).

Two- and three-class attributes sampling plans are the most commonly used plans for microbiological examination. In a two-class sampling plan, the test results of the samples analysed are divided into two categories, unacceptable or satisfactory, based on one limit value ($m = M$).

In a three-class sampling plan, the results of the samples examined are divided into three categories: unacceptable, marginally acceptable and satisfactory (CAC, 2004; EC, 2006).

Figs. 1 and 2 illustrate the parameters of a 2-class attributes sampling plan in comparison with a 3-class plan (adapted from Legan, Vandeven, Dahms, Cole, 2001).

In this example, a 3-class attributes sampling plan was used, as it is acceptable that some samples exceed the lower limit (m), as long as the maximum contamination level (M) is not exceeded.

The 3-class plan is defined by the values n, c, m and M as follows:

n = the number of analytical units to be tested
c = the maximum allowable number of analytical units giving values between m and M, i.e., the allowable number of marginally acceptable analytical units
m = the lower microbiological limit which separates conforming from marginally acceptable;
M = the maximum microbiological limit which defines non-conforming analytical units.

The size of the analytical unit (g) to be analysed is also specified.

The analytical units that comprise the sample should be obtained from the lot of food, defined as the group or set of

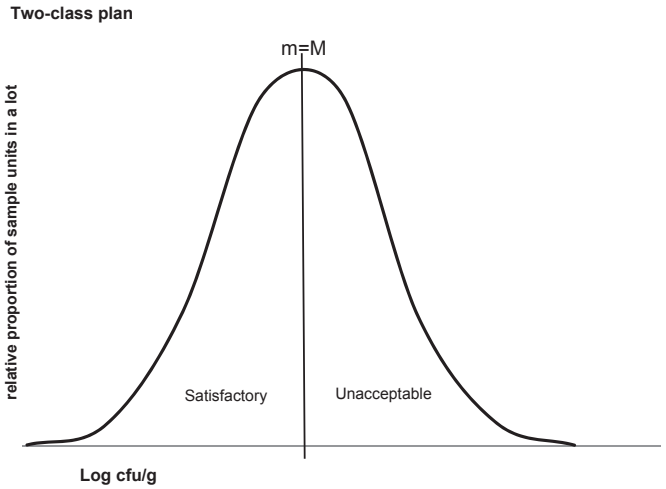

Fig. 1. Two-class attribute plan (adapted from Legan et al., 2001).