Quality Assurance Systems in the Food Industry.

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Introduction

Throughout the world, food manufacturing, distribution and retailing is becoming a highly complex business. Raw materials are obtained from sources worldwide, an ever-increasing number of processing technologies is utilised, and a vast array of products is available to the consumer. Such complexity necessitates the development of comprehensive control procedures to ensure the production of safe and high quality food. In addition, consumer expectations are changing, with a desire for convenience, 'less-processed' and fresher foods with more natural characteristics. Against this background the total food chain has to ensure that the highest standards of quality and safety are maintained. At all stages of the food chain, from acquisition of raw materials through retail or catering outlets, consideration must be given to quality issues associated with specific products, processes and methods of handling. There are a number of reasons why, especially in the agri-food business, implementation of quality assurance systems in an issue of the greatest importance.

Agricultural products are often perishable and subject to rapid decay due to physiological processes and microbiological contamination.

Most agricultural products are harvested seasonally.

Products are often heterogeneous with respect to desired quality parameters such as content of important components (e.g. sugars), size and colour. This kind of variation is dependent on cultivar differences and seasonal variables which cannot be controlled.

Primary production of agricultural products is performed by a large number of farms operating on a small scale.

This write up sets out to describe the currently available systems, how they can be used as tools for quality assurance management and outlines a framework for their interaction and use. Irrespective of size and complexity all food business must have an appropriate food quality assurance programme. Whilst at present quality assurance programmes focus primarily on food safety issues (e.g. Hazard Analysis Critical Control Points, HACCP), the general principles are equally applicable to the management of product quality in a wider sense.

Food Safety Issues

Despite the progress in medicine, food science and the technology of food production, illness caused by food-borne pathogens continues to present a major problem in terms of both health and economic significance. In 1990, an average of 120 cases of food-borne illness per 100,000 population were reported from 11 European countries, and estimates based on a more recent study indicate that in some European countries there are at least 30,000 cases of acute gastro-enteritis per 100,000 population (Notermans and Van der Giessen, 1993). Moreover, cases could be higher in Africa.

It is clear that only a small proportion of cases of food-borne illness are brought to the attention of food inspection, control and health agencies.

In addition we have seen the emergence of bacterial pathogens in recent years which may cause serious illness in susceptible individuals e.g. *Listeria monocytogenes* and verotexigenic *Escherichia coli* such as 0157:H7. Estimates have been made of the economic consequences of food-borne illness, where costs are incurred by individuals who become ill, their employers, families, health care agencies and food company or business involved. For example, in England and Wales in 1991, some 23,000 cases of salmonellosis were estimated to have resulted in overall costs of £40 - 50 million (Sockett, 1991)

Changes in food production systems

Significant changes are taking place in animal husbandry, large scale food production and distribution methods. The increased use of a range of raw materials and products originating from a wider range of countries has increased the potential for a geographical spread of diseases associated with particular contaminants. Many new processing techniques have been introduced which alone or in combination with each other, offer distinct product quality advantages, e.g. milder thermal processing, microwave, heating, ohmic heating and high-pressure processing techniques. All present new food safety challenges which must be fully evaluated.

Changes in consumer requirements

There is increasing demand for convenience foods, requiring minimal handling or preparation in user-friendly packaging. In addition, consumers are seeking foods which are more 'fresh' and with enhanced natural flavours which inevitably challenge the industry to use less harsh processing and production regimes.

Whilst there is little evidence that such trends have led to increased food-borne illness, it must be appreciated that these foods will require greater care in their production, distribution, storage and preparation prior to final consumption.

Socio-economic changes

There is a significant worldwide trend towards increased consumption of food outside the home. A major increase in the frequency of international travel for business and vacation purposes also means that more people are in touch with new type of products.

Population changes are taking place. The young and the aged are groups at risk with regard to food-borne illness in a number of countries the population is ageing, resulting in a stronger focus on health-related aspects.

Quality Assurance Strategy

Introduction

Quality assurance is a paramount importance to all companies and organisation involved in the production, sale and handling of food. Modern trading conditions and legislation require food businesses to demonstrate their commitment to food quality and establish an appropriate product quality programme. Such a programme should take into account the role of the business in the food chain, i.e. whether they are primary producers, manufacturers, retailers or caterers. A product quality programme contains four primary elements:

1. it meets the expectations of the consumer
2. it fits within the strategy of the company
3. it ensures that a company is clearly committed to the quality of its products
4. it aims for the highest quality level achievable.

Such programme should highlight where improvements are necessary and can usefully be applied to both organisational and technological issues. All company employees, from senior management to food handlers, should be aware of the significance a quality assurance programme. The programme should identify the key tools and their application to all stages of production, distribution and sale. An outline for such a programme is described and illustrated in **Figure 1.**

Development of a Quality Assurance Programme

Product Quality Strategy

Senior management in a company has ultimate responsibility for ensuring that the highest standards of food production and handling are achieved with respect to product quality. Total commitment to this aim is crucial for the successful implementation of such a programme.

The senior management should ensure a logical and structured approach to both organisational and product or process related activities.

A policy statement by senior management

Fig. 1 Development of Quality Assurance System

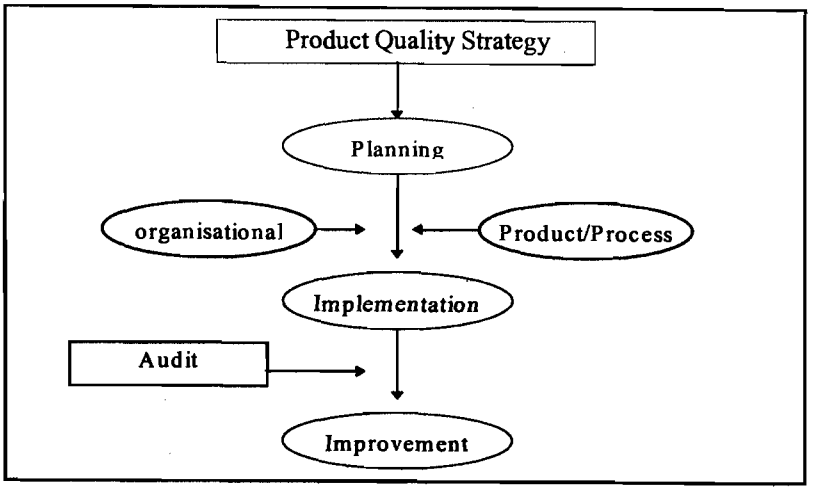


Fig. 2
GXP codes: A: code for good Agricultural Practice (GAP), applicable to all producers of carrots; B: conserved carrot production chain (vertical integration); C: fresh carrot production chain (vertical integration); D: code for Good Hygienic Practice (GHP), applicable to all greengrocers but not for the production of conserved (e.g. deep frozen or canned) carrots

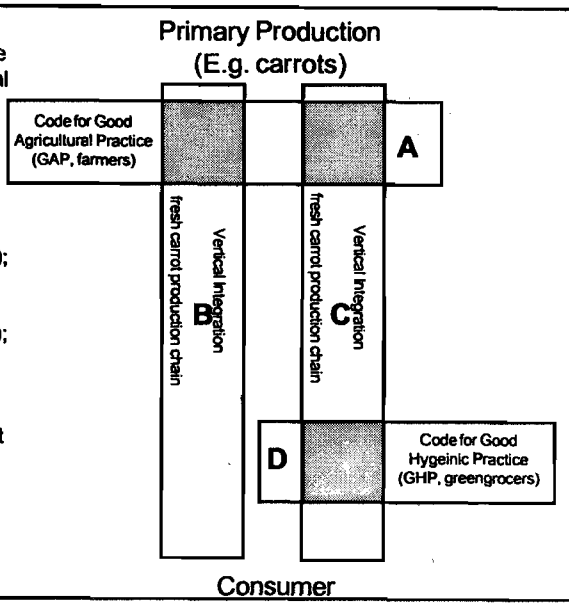
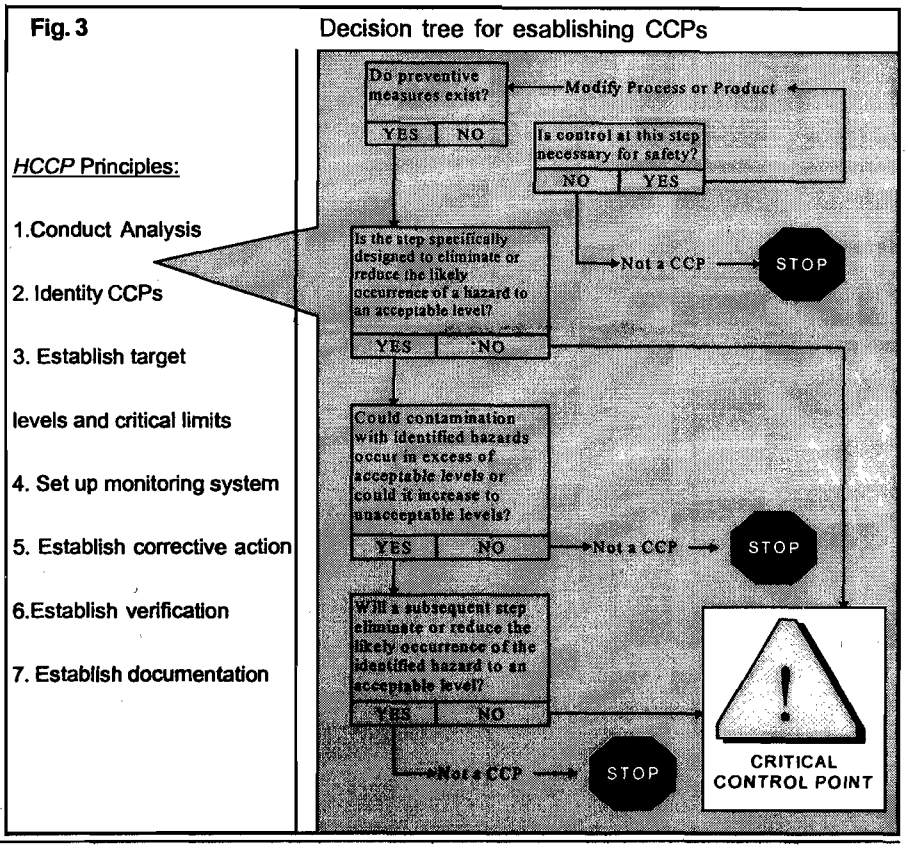


Fig. 3 Decision tree for esablishing CCPs



should outline the general approach to ensure production and handling of food products with the desired quality. The company should make sure that the food policy concerning product quality is appropriate to the nature and activity of the business provides a commitment to continuous improvement complies with legislation is fully communicated, understood and supported by all employees

Planning

Organisational planning should include the preparation of a detailed quality assurance programme. This should clearly define aims, assignment of responsibility, resources, requirements and lines of communication to gain full commitment from all personnel to the quality assurance programme. This process, through assessment and auditing, should seek continuous improvement.

Product and process planning should result in the definition of clear and unambiguous requirements, for example with respect to food safety. All such requirements should be based on a full consideration of constraints, opportunities and other relevant factors. Constraints may include regulatory and commercial requirements. Opportunities may include product development, process innovation and new markets. Other factors may include economic issues and costs such as those of raw materials.

Implementation

The first requirement is a thorough understanding of all stages of the production cycle from raw material production and acquisition through to finished goods and their use. This will include a detailed knowledge of product-process interaction, product and process specifications, monitoring and verification procedures and methods for dealing with non-compliance. With this knowledge, a detailed analysis can be undertaken to identify those factors which may affect quality. Appropriate control measures can then be identified and implemented. It is essential to fully document this analysis which will describe the procedures to ensure compliance with quality assurance requirements and the operational criteria necessary for product and process control. A number of specific tools have been developed to carry out this analysis, some of which have already been widely used in the food industry e.g. HACCP.

Audit (Assessment of performance)

Senior management should ensure that there is a process or regular assessment of performance of the food safety programme. This can be done internally or externally and will include audit of individual stages and identification of any weaknesses. In this way an assessment can be made of whether the quality assurance requirements are being met and whether the programme is truly effective.

Improvement

The analysis and assessment process is likely to identify issues for adjustment, modification and improvement. These should be undertaken and appropriate follow-up carried out. This is an on-going review process designed to ensure compliance with changing regulations and further enhance the assurance of food safety.

Tools for quality assurance

The practical success of any quality assurance programme will depend on the proper use of appropriate methods and tools. These will include Good Hygienic Practice (GHP), Good Manufacturing Practice (GMP) and HACCP specifically targeted to food safety (Institute of Food Science and Technology of the U.K., 1986 and 1993). Other tools of more general application are quality assurance methods and systems such as the ISO 9000 series of standards and the Total Quality Management (TQM) approach.

Good Manufacturing Practice (GMP) and Good Hygienic Practice (GHP)

GMP covers the fundamental principles, procedures and means needed to design a suitable environment for the production of food of acceptable quality. GHP describes the basic hygienic measures which establishments should meet and which form the prerequisites to other approaches, in particular, HACCP. GMP/ GHP requirements have been developed by governments, the Codex Alimentarius Committee on Food Hygiene (FAO.WHO, 1995), and by the food industry, often in collaboration with other groups and food inspection and control authorities. Development of GMP codes is taking place in various areas of industrial production. These codes establish quality assurance procedures which can be implemented in a specific field of production, both at company and sector level (horizontal integration, as shown in **figure 2**). For several types of production, specific codes have been developed at the international accepted codes. Sometimes the abbreviation GXP is used for this type of code.

General GHP requirements usually cover the following:
the hygienic design and construction of food manufacturing premises,
the hygienic design, construction and proper use of machinery,
cleaning and disinfection procedures (including pest control)
general hygienic and safety practices in food processing including:

- the microbial quality of raw foods
- the hygienic operation of each process step
- the hygienic of personnel and their training in food hygiene and safety.

Good Manufacturing Practice codes and the hygienic requirements they contain are the relevant boundary conditions for the hygienic manufacture of foods. They should always be applied and documented.

Until recently GXP codes have been implemented on a national basis for a specific branch of industry. Although implementation is most often voluntary, companies which have not adopted the code - or an equivalent quality system - may have problems staying in business, especially when vertical integration of food production chains occurs. Various quality programmes and production codes for the production of meat, milk and eggs in the Netherlands stipulate the compound animal feeds must be supplied by feed manufacturers which work according to the Dutch code for Good Manufacturing Practice. At present virtually all feed producers in the Netherlands comply with this code: they have either adopted the code or have gone out of business.

General codes have been developed by international bodies, for instance by the International Dairy Federation (International Dairy Federation, 1980) and Codex Alimentarius (Codex Alimentarius, 1985). These codes may serve as a starting point for the development of GXP codes for a specific purpose. It must be stressed that, in general, adjustments

must be made with respect to specific branches of production, or to cover situations which are specific to a certain country. The same is true for companies adopting a GXP code: in most cases some fine tuning with respect to specific conditions within the company will be necessary. Care must be taken to avoid unnecessary procedures: some codes have been nicknamed 'codes for Getting More Paperwork'! GXP codes must be lightweight systems, applicable especially in small companies which either do not require a full-sized quality system, or which are not able to develop and maintain such a system.

The HACCP system

The development of the system which is now known as 'HACCP' (Hazard Analysis Critical Control Point) can be traced back to at least 1972. In that year cooperation between the International Commission on Microbiological Specifications for Foods (ICMSF) and the World Health Organization (WHO) was established. In 1988, the results of this cooperation were laid down in a book (Thatcher et al., 1988). Since then, the system and its application has also been described in documents of Codex Alimentarius (Codex Aimentarius, n.d., 1955a and 1955b). The European Union adopted the HACCP approach in Directive 93/43, which means that HACCP is now a part of national legislation in all member states of the European Union (Anon, 1993).

HACCP is a food safety management system which is based on systematic identification and assessment of hazards and risks associated with the production of food (Dillon and Griffith, 1996). Although originally developed to control micorbiological hazards, the approach can also be used to identify the assess hazards of chemical and or physical nature. Examples of chemical hazards are residues of pesticides in plant raw materials and the presence of aflatoxins in peanuts. Aflatoxins are highly toxic mycotoxins, produced by *Aspergillus flavus*. The substance occurs naturally in crops grown in hot and humid conditions. Examples of physical hazards are small stones which may be present in dried currants, or bones in fish fillets.

When all hazards are known Critical Control Points (CCPs) can be identified: points or steps in the production process at which control can be applied and a food safety hazard can be prevented, eliminated or reduced to an acceptable level. Following the identification of critical control points, preventive measures (or control measures) must be put into practice. Critical control points which have been identified must be monitored: checking that the processing or handling procedures at a CCP are under control. Corrective action must be taken when monitored values are above established critical limits. As with other quality systems, verification on a regular basis is required. A scheme showing the principles of HACCP and a decision tree which can be used to identify CCPs, as developed by Codex Alimentarius, is shown in Figure 3.

Much experience with the development and implementation of HACCP systems has now been accumulated. It appears, however, that there are still major problems associated with implementation, especially in small companies, where there is often not enough scientific knowledge available. There is also still debate in scientific circles concerning the extent to which the severity of risks must be estimated: most often it is a matter of setting priorities, since not all identified hazards can be eliminated in one operation. Priorities are often set on the basis of budgetary consideration rather than scientific knowledge about hazards.

Hygiene codes, when based on HACCP principles, can play an important role in implementation of HACCP systems, especially for small businesses.

As with the implementation of GXP codes, in most cases some fine tuning with respect to specific conditions within the company will be necessary. It is appropriate to highlight the chemical hazards: in contrast to physical or microbiological hazards, a chemical hazard does not often lead to customer complaints. The risks associated with chemical hazards are often not of an acute toxicological nature but have to do with long-term exposure of consumers to low levels of unwanted substances. If a company is recording complaints, these records can often be used to estimate the occurrence of physical or microbiological hazards, but mostly there are insufficient data on chemical hazards.

Chemical hazards are often associated with raw materials, for instance in the case of the presence of contaminants in such commodities. Numerous countries have not introduced legislation setting maximum levels for a great number of contaminants. Contaminant level often cannot be influenced during the production of food and not much knowledge on the fate of contaminants during processing is available. This means that these hazards often must be controlled using specifications for the raw materials. Such specifications must be realistic: there is no point in specifying zero tolerance (i.e. demand the complete absence of a contaminant) when it is clear that such a demand cannot be fulfilled by the supplier. It is expected that the development of production chain based HACCP systems will be an important topic in the near future (Whiting, 1995).