Introduction of an Accredited Quality Control System in a Postharvest Laboratory: the Fairy Garden Beyond the Paper Mountain?

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Abstract

The Flanders Centre of Postharvest Technology (VCBT) has introduced an accredited quality control system according to the ISO/IEC 17025 standard. The accredited scope covers the measurements of quality attributes of fruits and vegetables. The implementation of the system involved the fulfilment of several management and technical requirements. Therefore a well structured document flow was established. Whereas for some measurements ISO standards were available, for other methods new procedures, calibration and validation methods had to be developed. A lot of effort was paid towards developing a training program for the staff. Also an efficient monitoring and control of the work and the storage conditions was necessary to produce valid test results. This accreditation has made it possible to meet the requirements of the customers of the VCBT, i.e. the Belgian Fruit and Vegetable Auctions.

INTRODUCTION

Nowadays, consumers and retailers are not only concerned about the safety and the quality of fruits and vegetables, but also about the way they are produced. Leading European food retailers have established the EUREP GAP Protocol, which describes best practice for global production of fresh produce and horticultural products. Because of legislative and market pressures, fruit and vegetable auctions also need to comply with quality standards (HACCP, ISO 9002). This implies that, when auctions appeal to laboratories for routine analyses of quality attributes, such as absence of residue and microbial contamination, firmness, and soluble solids content, they expect reliable test results. For this reason the Flanders Centre of Postharvest Technology (VCBT), has decided to implement a quality system according to the ISO/IEC 17025 standard. Moreover, an accredited quality system in the VCBT was necessary to improve the internal quality of the measurements, to have a competitive advantage and to meet the market demands. In this way the laboratory intends to guarantee its competence to generate technically valid test results. The aim of this paper was to give a short overview about the quality systems applied in the industry of fresh fruits and vegetables and to outline the experience of the VCBT with the implementation of an accredited quality system with special emphasis on the unavoidable administrative burden, calibration and verification of measuring equipment and education of personnel.

FOOD STANDARDS

Why have standards become so important?

Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose (ISO, 2002). Applying this definition to the food industry we can say that food standards are agreed sets of criteria for ensuring consistent manufacture of food products from a safety, nutritional or management system perspective (Boutrif and Bessy, 1999).

These standards may be required by law or by the market. There are various bodies that set food standards. For products sold internationally, these include the Codex Alimentarius Commission (CAC), the International Standards Organisation (ISO) and various markets, such as the European Union (ASQ, 2000).

Since the last 20 years consumers have become more and more concerned about the quality and the safety of all kind of food products (fresh produce of fruits and vegetables, frozen foods,…). Consumers have higher expectations of the quality of the products but they also want to know how the products are produced. This is why the retailers have responded by developing systems to measure, manage and improve the quality of products and the production process more effectively. Standards are used to provide consumers with information about the product, to maintain product quality uniformity, to establish market value, and to prevent economic fraud (FDA, 2000).

Food quality

Quality is defined by the International Organisation for Standardisation (ISO) as “the totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs.” In other words, to be considered a quality product it has to meet the requirements of the consumers (Van Reeuwijk, 1998). This means that quality is a term defined by the consumer, buyer, grader or any other client based on a number of subjective and objective measurements of the food product. These may include measures of purity, flavour, colour, maturity, safety, nutrition or any other attribute or characteristic of the product (Lineback, 2002).

SAFETY AND QUALITY CONTROL SYSTEMS

Before beginning to produce any product, processors must be aware of consumer and government expectations, including those related to food safety, sensory characteristics, other regulatory requirements and specific customer or foreign country requirements. Once these expectations are known, the processors can design a control system which provides a reasonable level of assurance that they will be met (McEachern et al, 2001).

Safety and quality control systems should be ongoing processes incorporating activities beginning with selecting and preparing the soil and proceeding through to consumption of the product. Both safety and quality assurance should focus on the prevention of problems, not simply curing them since, once safety or quality is reduced, it is virtually impossible to go back and improve it for that item. It is possible, however, to assure that the same problem does not affect future products. Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Sanitation Standard Operating Procedures and HACCP-like (Hazard Analysis Critical Control Point) activities are programs which may be used at various stages in the farm to table chain to improve the safety of fresh fruits and vegetables (Lineback, 2002).

Also at the level of laboratories the implementation of quality control systems is necessary to produce consistently reliable data. The customers now demand the laboratories that their test results meet established quality requirements.

To ensure that these quality control systems are effectively implemented and maintained they are subjected to external audits from independent inspection, certification or accreditation bodies. The government body in Belgium that controls the accreditation of laboratories is BELTEST. The British equivalent accreditation body is UKAS.

EUREP GAP

In Europe the Leading European food retailers have established the EUREP GAP Protocol, which describes best practice for global production of fresh produce and horticultural products. EUREP (Euro Retailer Produce Working Group) uses GAP as a framework for verification. It is at present specifically designed for business in the fresh produce supply chain. It offers a means of incorporating Integrated Crop Management (ICM) and Integrated Pest Management (IPM) practices within the framework of commercial agricultural production. EUREP GAP ensures retailer and consumer confidence through responsible and sustainable production and it complies to the minimum standard acceptable to leading retail groups in Europe. It also supports the basic principles of HACCP (Hazard Analysis Critical Control Point) (SGS, 2001).

In the near future primary producers who follow the EUREP GAP guidelines will have priority to supply to some retailers. So it will become very important for the producers to implement the EUREP GAP system in order to stay competitive in the market.

HACCP

A food safety assurance program often used by the food processing industry is the HACCP system. HACCP is a systematic approach to the identification, evaluation and control of food safety hazards. Preventing problems from occurring is the paramount goal underlying any HACCP-like system. These systems focus attention on the parts of the process that are most likely to affect the safety of the product (Lineback, 2002). The application of HACCP is normally described in terms of seven principles which have been formalised by groups such as the Codex Alimentarius of the Food and Agriculture Organisation of the United Nations. These principles are as follows (Dix, 2001):

1) Conduct a hazard analysis
2) Determine critical points (CCP’s)
3) Establish critical limits
4) Establish monitoring procedures
5) Establish corrective action system
6) Establish verification procedure
7) Establish documentation and a record keeping system

As far as the fresh produce of fruits and vegetables is concerned, the vegetable and fruit auctions need to comply with the HACCP system. When applying this system it is assured that the products which are sold by the auctions are treated in a safe and hygienic way. For instance, a critical point in the HACCP system of the auctions is an optimal cooling to maintain the quality of the products. A reliable system to monitor the temperature in the cooling cells is, therefore, necessary. Food safety is mainly addressed by microbiological, biological, chemical and physical decontamination procedures.

Quality Control in Laboratories

For analytical laboratories in the food sector there are legislative requirements regarding analytical data which have been adopted by the European Union. However, the Union now recognises that the competence of a laboratory (i.e., how well it can use a method) is equally important as the ‘quality’ of the method used to obtain results. This is best illustrated by consideration of the Council Directive on the Official Control of Foodstuffs (OCF) which was adopted by the Community in 1989. Eventually this has lead to the Directive on Additional Measures Concerning the Food Control of Foodstuffs (AMFC). This AMFC Directive requires that food control laboratories should be accredited to an internationally recognised standard, should participate in proficiency schemes and should use validated methods. Although the legislative requirements apply only to food-control laboratories the effect of their adoption is that other food laboratories will be advised to achieve the same standard in order for their results to be recognised as valid results (Wood, 2001).

The appropriate standard for the accreditation of testing laboratories is the ISO/IEC 17025 standard ‘General requirements for the competence of testing and calibration laboratories’. This standard has been produced as the result of extensive experience in the implementation of ISO/IEC Guide 25 and EN 45001, both which it now replaces. In fact this standard contains specific guidance on technical competence requirements not covered by ISO9001/2. To comply with the ISO/IEC 17025 Standard, several management and technical requirements need to be fulfilled.

IMPLEMENTATION OF ISO/IEC 17025 IN THE VCBT

Flanders Centre of Postharvest Technology (VCBT, vzw) is a non profit research organisation which has been established by the Belgian Fruit and Vegetable Auctions and the Catholic University of Leuven. This centre carries out applied and basic research in the area of storage technology and quality of fruits and vegetables and provides consultancy and extension services to the horticultural sector in Belgium.

As stated in the introduction, the Belgian Fruit and Vegetable Auctions also need to comply with quality standards (HACCP, ISO 9002). Consequently, when the auctions appeal to the VCBT for routine analyses of quality attributes such as soluble solids content, titratable acidity, firmness, colour of fruits and vegetables, they expect reliable test results. For this reason the VCBT has decided to implement a quality system according to the ISO/IEC 17025 standard. In this way the laboratory intends to guarantee its competence to generate technically valid test results.

In the following paragraphs the experience of the VCBT with the implementation of this quality system is outlined.

Scope

The scope of the accreditation of the VCBT according to ISO/IEC 17025 involves the following routine methods for measuring quality attributes of fruits and vegetables (more particularly, quality attributes of apples, pears, tomatoes and cherries):

1) Determination of the soluble solids content of fruits and vegetables using the refractometric method (ISO 2173, 1978).
2) Determination of the firmness of hard fruit by means of a Universal Testing Machine (ASAE S368-4, 2000).
3) Determination of the titratable acidity of fruits and vegetables (ISO 750, 1998).
4) Measurement of the colour of fruits and vegetables using the spectrophotometric method (ASTM E1164, 2002).
5) Determination of the weight and diameter of fruits and vegetables (NEN-EN 45501, 1992 and DIN 862, 1988).
6) Determination of the starch degradation of hard fruit (CTIFL ‘Starch test’ with EUROFRU colour card, Chapon et al., 1996).
7) Determination of the firmness of tomatoes using an acoustic firmness sensor (Schotte et al., 1999).

These test methods are described in international, national or regional standards or by reputable technical organisations, or in relevant scientific texts or journals, or as specified by the manufacturer of the equipment. Laboratory-developed methods may also be used if they are appropriate for the intended use and if they are validated. In other words the ISO/IEC standard covers testing and calibration performed using standard methods, non-standard methods and laboratory-developed methods.

Management requirements

As far as the management is concerned, the VCBT has taken into account the following requirements. The laboratory had to be legally identifiable, independent and impartial. For this reason it was important to have a clear description of the organisation and management structure including the relationships between the quality management, technical operations and support services. Also arrangements were established to ensure that no pressure is put on the staff members nor manipulating of the results will occur. With respect to this, the VCBT- Board members have signed a declaration.

The laboratory’s quality system policies and objectives had to be defined in a quality manual. Procedures had to be established (see next paragraph) to control all documents that form part of the quality system. Also procedures were implemented concerning the review of requests, subcontracting of tests, purchases of services and supplies. An important quality goal was the fulfilment of customers requirements. It was necessary for the laboratory to have feedback from their clients. This feedback is used to improve the quality system. Another important element of the system was the description of the preventive and corrective actions when problems occur. When developing these procedures it was important to consider long-term solutions to prevent the recurrence of that problem in the future. This preventive and corrective strategy is also implied when complaints are received from customers. To determine the effectiveness of the quality system the standard requires that laboratories conduct internal audits of all aspects of the system at least once a year. The corrective actions emerging from such an internal audit ensure that the quality system is kept up to date. A last management requirement is referring to the management review. This review needs to be carried out by the laboratory's executive management in order to ensure the suitability and the effectiveness of the quality system and to introduce necessary changes or improvements.

Technical requirements

As the technical competence is an important issue in the ISO/IEC 17025 standard, the VCBT has considered the following technical requirements. An appropriate training of the personnel is necessary to guarantee valid test results. To demonstrate the competence of the staff these qualifications need to be registered in records. The accommodation and environmental conditions in the laboratory should be suitable in order to carry out the measurements accurately. For example, analytical balances should not be placed in an environment were there is a draught. Many auditors are concerned a lot about the validation of the methods and the estimation of the measurement uncertainty. For each measurement that is performed in the laboratory the repeatability, the reproducibility, the accuracy, the measuring range, etc. need to be defined. Using these validation parameters it is not to difficult to calculate the measurement uncertainty. It's quite important to know these parameters for each method otherwise it cannot be estimated how reliable the test results are. Another technical term frequently used in accredited laboratories is traceability. It is necessary to have a suitable calibration programme for all instruments that influence the final test result and calibrations should be traceable to national or international reference standards. The standard requires also that laboratories introduce internal and external quality control procedures. With respect to internal control procedures a distinction is made between the procedures that can be carried out by the laboratory assistants itself and the control procedures that are performed by others. The external quality control is taken care of by participation in proficiency testing schemes, i.e. determination of laboratory testing performance by means of inter-laboratory comparisons. Control samples are sent to different laboratories and by comparing the obtained test results the laboratories are provided with a means of objectively demonstrating the reliability of the data they produce. A last requirement includes the reporting of the test results. The reports need to be written clearly, accurately and objectively containing all the information for interpretation of the results.

Documentation structure

It's essential that the documentation structure of the quality system is well defined otherwise the staff will get lost in the huge paper burden. To meet all the requirements stated in the standard the VCBT has three levels in the quality documentation, although for a small company it may be kept under one level:

At the first level the *quality manual* is defined. It contains the policies and headline procedures covering each key area of the quality system, e.g. policies concerning staff training, safety,... The quality manual provides overall guidance and is available to customers.

The second level forms the major part of the system and provides detailed instructions (= *procedures*) on how the laboratory needs to carry out the principal operations, e.g. how to deal with complaints, how to review requests, tenders and contracts,… These procedures form the bible from which the laboratory will be expected to operate and will be audited against.

The third level consists of the *work instructions* which are carried out at the 'laboratory-floor'. These instructions are formulated in such a way that each new staff member can, with only a small amount of training, carry out the job effectively. The instructions to carry out the analyse methods of the VCBT (see scope) are belonging to this level.

A widely used quality assurance phrase related to documentation should always be kept in mind: ‘What not has been documented was never done.’

EXPERIENCES

To the author’s knowledge the VCBT is the only European postharvest laboratory that has obtained such an accreditation so far. The VCBT has experienced that the implementation was a tough job because at the beginning of the accreditation process it looks like more emphasis is put on formalities than on the quality of the results. Once the formalities became more and more routine for all the staff members, the initially negative attitude was converted into a positive one and into a certain pride. For some people a positive attitude towards accreditation was created by involving them actively in writing procedures. A well organised and transparent document flow can minimise the administrative work to a certain extent. Why are five different forms needed to register non-conformities as complaints, equipment problems, …if one form can handle this registration? Implementing information technology in the documentation structure also facilitates the document organisation in the VCBT. Procedures can be consulted by the staff members on computers and several forms can be filled out electronically. However, in practice it is often found that procedures are easier to read on a hardcopy than by computer.

In case of measurement methods which are not commonly used in other laboratories, it was not obvious to find suitable reference materials to guarantee the traceability. It is essential to realise that an annual calibration of the equipment is not sufficient, the instruments must be subjected to periodic intermediate checks, i.e. verifications between calibration although for some instruments this is quite time-consuming. For instance, the quality verification of the acoustic firmness sensor (Fig. 1) consists of a monthly frequency control by means of tuning forks and a weight control using control weights. Frequency and weight are in fact the determining factors in the calculation of the acoustic firmness of fruits. It is also not evident to find appropriate proficiency testing schemes and control samples, but in most cases it is sufficient to use imagination to solve these problems. For example, a squash ball can be used as an appropriate control sample for a universal testing machine that is measuring the firmness of fruits by pushing a plunger into the fruits over a certain distance. To participate at proficiency testing schemes the VCBT is appealing to BIPEA (Bureau Interprofessionnel d’Etudes Analytiques) for measuring the soluble solids content and the titratable acidity of fruit juices.

It is important that the staff is carefully trained in the use of the measurement techniques because many measurements seem quite simple to perform but are potentially subject to errors because they include some manual work. On the other hand the VCBT has noticed that too much automation can lead to a lower accuracy. For instance it seems that pipetting large volumes with automatic pipettes is less accurate that manual pipetting.

In a postharvest laboratory like the VCBT the working and storage environment need to be well structured and controlled. For example the temperature, the humidity and the gas conditions (CO_2, O_2 and N_2) are playing an important role in the storage process of fruits and vegetables so it is necessary to monitor these parameters accurately. In the VCBT fruits and vegetables are stored in different cool rooms. To simulate different environmental conditions 30 CA containers (controlled atmosphere) and 30 CA plastic bags are used (Fig. 2). The environmental parameters are automatically registered and controlled by a computer system. The system generates history plots of the parameters. A weekly control of these plots is carried out in order to detect small set point deviations. Larger deviations are registered by a alarm system that informs the staff of the technical support immediately. This system ensures that these parameters stay optimal and that appropriate preventive and corrective actions are taken when problems may occur.

From the point of confidentiality and safety the access to the laboratory needs to be restricted to authorised staff. Therefore a new VCBT-laboratory was constructed of which the access can easily be controlled (Fig. 3). The access is realised by means of a badge system which allows access to VCBT-staff and other competent users of the measurement equipment. This restricted access was considered of large importance because the new infrastructure is located in the same building as several other university laboratories. Visitors of the laboratory are registered in a log book and they are always accompanied by VCBT-staff during their visit. Confidentiality of produced data is taken care of by a special VCBT-directory on the computer net work. All the measurement results and raw data are saved on this directory and only VCBT-staff members have access to it. Furthermore, the computers are locked when computer users are leaving their desks.

To achieve the final accreditation, the VCBT was subjected to several audits. First the Belgian accreditation body BELTEST has performed a preliminary audit to determine the acceptability of an initial accreditation. Then all the elements of the quality system were controlled during an internal audit, partially performed by the quality manager of the VCBT and by the quality manager of another testing laboratory. Finally, when the management review was completed by the scientific coordinator, the laboratory was ready to be audited against all the requirements of the ISO/IEC 17025 standard during the initial BELTEST-audit. All these audits have resulted in detailed action plans which were implemented in a positive way and which have lead to the achievement of the accreditation.

A final consideration is that a quality system is a continuous developing system that will never be finalised. The quality manager therefore will always have some work in prospect.

CONCLUSIONS

As quality systems have become an essential element in successful companies and organisations, the VCBT has also introduced a quality control system according to ISO/IEC 17025. The implementation of the quality system has made it possible to improve the quality of the performed measurements. In the implementation much emphasis was put on the training of the personnel, the maintenance of the equipment and the infrastructure of the laboratory.

The customers of the VCBT, i.e. fruit and vegetable auctions, are now assured that the measurements of quality attributes are carried out by competent personnel in a highly accurate way. Consequently, the requirements of the clients are met which means that the most important goal of the quality system is achieved.

Implementing this ISO system involved relatively high costs: the purchase of reference and calibration material, standards,…. The additional annual cost mainly comprises audit costs and costs for service contracts of measuring equipment. The biggest disadvantage of an accredited laboratory seems to be the increase in registration work. Using an easy-to-understand documentation structure, this problem can be minimised and the fairy garden beyond the paper mountain can be discovered.

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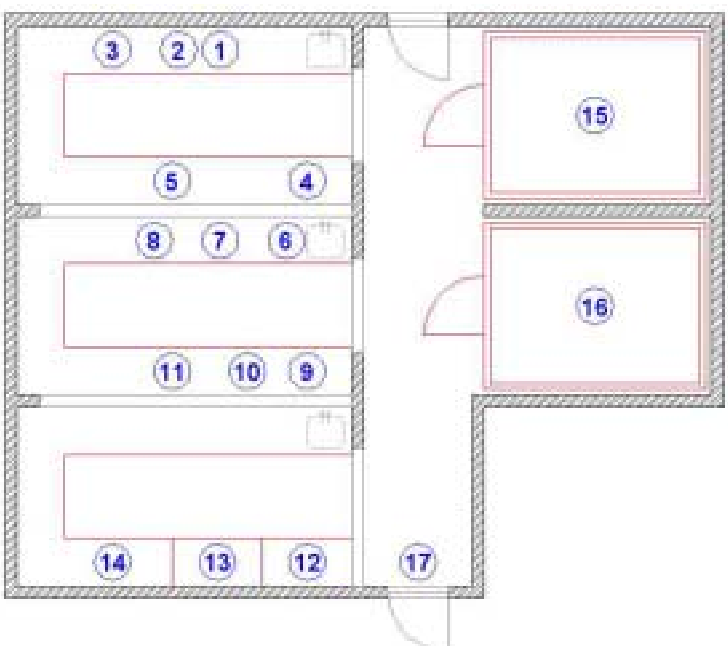
Figures

Fig. 1 Acoustic firmness sensor (AFS, Aweta, Nootdorp, The Netherlands)

Fig. 2 CA plastic bags (controlled atmosphere) to store fruits.



1. Cooling incubator
2. Cooling incubator
3. Analytical balance
4. Universal testing system
5. Balance
6. Automatic titrator
7. Spectrophotometer (colour)
8. Acoustic firmness sensor
9. Pendulum
10. Shaker
11. Near infrared spectrophotometer
12. Hood
13. Storage of chemicals
14. Laminair flow
15. Cool room
16. Cool room
17. Entrance with badge system

Fig. 3 Infrastructure plan of the VCBT-laboratory with indication of the equipment.