

## RETHINKING VALIDATION AND VERIFICATION THROUGH SCIENTIFIC DATA FRESHNESS IN ORDER TO MEET FOOD SAFETY MANAGEMENT REQUIREMENTS - A CASE STUDY

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### Abstract

*In the light of new and relevant scientific information regarding the increased risk of association of OTA hazard with food commodities such as meat and organs, on one hand and considering the documented update available through the scientific data freshness indicating the appropriateness of HPLC for increased performance in OTA testing in such food commodities, on the other hand, we assessed the need of re-validation and re-verification of OTA control measures in two example food products. The results of this assessment indicated that re-validation and rethinking of verification are strongly needed from the perspective of FBOs responsibility in guaranteeing the safety of their final products. The results of re-validation and re-verification processes for "toba" meat product and for generic pork ham, as dried cured meat product, as presented in verification charts and discussed, were proven appropriate for the considered case study.*

**Key words:** validation, verification, scientific data, food safety management.

### INTRODUCTION

Control measures have been used as basic instruments for the management of hazards potentially associated with foods, being applied through the food safety management systems all throughout the food chain, starting from the primary production, and ending with the consumption of the finished product. As stated by the Codex Alimentarius guidelines of HACCP system application (CAC/RCP 1-1969, Rev 3, 1997), flexibility is crucial when applying HACCP, due to the high variety of food business operations (FBO). This flexibility is also available in the selection of specific control measures, which is the reason why their validation and verification acquire increasing significance especially when the safety of the final product is the responsibility of the industry.

Validation, as defined by Codex Alimentarius (Codex Alimentarius Food Hygiene Basic Texts. Food and Agricultural Organization of the United Nations, World Health Organization, Rome, 2001), means obtaining

evidence that the control measures managed by the HACCP plan and by the operational PRPs are capable of being effective. Verification is confirmation, through the provision of objective evidence that specified requirements have been fulfilled [ISO 9000:2000, definition 3.8.4]. Validation brings evidence that the HACCP plan is effective, while verification brings evidence that the HACCP plan is followed as designed and implemented. Validation, on one hand, is performed at the time a control measure or a food safety control system is designed, whenever possible, performed before their full implementation, or when changes indicate the need for re-validation. It is through the validation process that the food business operators prove that the selected control measures are actually capable, on a consistent basis, of achieving the intended level of hazard control. Verification, on the other hand, uses methods, procedures and tests, other than those used in monitoring, to determine if HACCP procedure results are in compliance. Verification is performed after the full implementation of the food safety system,

as an after-the-fact check of the system, to assure that the controls are appropriate and have been correctly implemented, meaning that the system is operating according to the plan. Validation is focused on the collection and evaluation of scientific, technical and observational information to assess the capability of selected control measures of achieving their specified purpose in terms of hazard control. Validation involves measuring performance against a desired food safety outcome or target, in respect of a required level of hazard control (CAC/GL 63-2007; CAC/GL 21-1997).

The industry and the competent authorities have different roles and responsibilities in validating control measures. While governments ensure that FBOs have effective systems for validation and control measures are appropriately validated, sometimes providing guidance in performing validation studies, in support of risk management decisions to be made by the industry, industry holds the complete responsibility for the correct validation of control measures applied within the food safety management system.

It is a fact that among the numerous methods of validation (review of prerequisite program, review of HACCP plan, and review of customer complaints), scientific data consultation and updating is the most important and, sadly, the most overlooked element. Science is strongly connected with the hazard and the control measure. Therefore, since validation needs scientifically based answers, validation and consequently, verification may need rethinking along with science updates. This study aimed to bring into the spotlight of public interest, food scientists and food safety managers in the industry, the relevance of scientific findings in the design and application of validation and verification within the management of food safety.

## **MATERIALS AND METHODS**

The paper illustrates a case of new scientific information related to ochratoxin A (OTA) contamination of pork organs and the performance of OTA testing methods in these particular food commodities, with special focus on the effect of these scientific findings over

the food safety management system, in a regular meat processing plant. Based on the diagram flow of an example meat product manufactured from potentially OTA contaminated raw material, we discuss the new approaches of validation and verification that are the responsibility of the FBO in this context.

## **RESULTS AND DISCUSSIONS**

In the case of new scientific data brought to light by articles that documented higher prevalence of OTA in pork kidneys and the recommendation of choosing HPLC over ELISA in OTA testing in pork kidneys (Georgescu M. et al, 2013), we evaluated the need to perform revalidation of OTA control measures of the HACCP plan for two different products, based on the diagram flow of their technological process.

The maximum residue limits (MRL) were documented from Regulation no.1881/2006 (as amended by both Regulations 1126/2007/EC and 105/2010/EU), as well as from the former Romanian legislation (Ord. 975/98), which was repealed after implementation of European legislation. Since Regulation 1881/2006 does not contain maximum limits for ochratoxin in meat or organs, we considered for discussion the limits established for ochratoxin A in meat, by Ord. 975/98: 20 µg/kg for meat and organs (5 µg/kg in foods for children under the age of three).

An effective HACCP system requires verification that application of the CCPs is achieving the goal of appropriate mycotoxin levels in the commodity. The HACCP system must be documented and a system of recording developed for the monitoring of CCPs and corrective actions. Thus, it is the responsibility of the FBO to have his products controlled for mycotoxin content at the point of sale. Sampling and analysis should be carried out in accordance with the principles outlined in Commission Directive 98/53/EC, which refer both to official controls and to sampling and analysis carried out by FBOs. Laboratories selected by the FBO should be accredited and should be able to comply with the requirements of Regulation 401/2006.

The statutory sampling procedures for commodities likely to be contaminated by mycotoxins have been set out in Commission Regulation 401/2006, laying down the methods of sampling and analysis for the official control of the levels of mycotoxins in foodstuffs, which is a consolidated version of previous sampling and analysis Directives for the individual mycotoxins. Nevertheless, no methods for sampling mycotoxins in meat and organs are available in the enforced Directives and Regulations.

In addition to the overall responsibility placed on FBOs by the General Food Law (Directive 178/2002) to supply safe food, FBOs must also ensure that their products comply with the legislative limits for mycotoxins as laid down in Commission Regulation (EC) No 1881/2006 as amended. It is important that FBOs identify CCPs in their processes that may result in mycotoxin contamination, such as storage conditions that may lead to the development of mould. The identification of appropriate CCPs along their process chain will enable them to develop and apply proper HACCP systems which will ensure that there are no unforeseen sources of mycotoxin contamination in their products. If moulds capable of producing Ochratoxins A are contaminating the dry-cured meat products, the level should not expose the consumers to a point that exceeds the maximum tolerable daily intake of OTA, as set by the European Food Safety Authority (1.2-14 ng/kg b.w. per day, EFSA, 2010).

Recent studies (Georgescu M. et al, 2013) indicated unusually high levels of OTA in pork kidneys, namely  $\approx 20 \mu\text{g}/\text{kg}$  sample. This level of contamination is high when compared to other average contamination levels of the same product, communicated by different authors:  $0.36 \mu\text{g}$  OTA/kg, with values ranging from  $0.11$  to  $0.67 \mu\text{g}$  OTA/kg, as reported by the Hong Kong Centre for Food Safety (2006). Moreover, the same authors indicated that in certain conditions, this level of contamination would pose a serious threat to exceeding the maximum tolerable daily intake of OTA, as set by the European Food Safety Authority.

Also, more relevant new information is brought to attention by the same authors, which compare the performance of two analytical methods for OTA testing in pork kidney

samples: results of analysis of two naturally contaminated kidney samples using ELISA and HPLC indicate that the OTA content is close to the MRL (Ord. 975/98), without exceeding, using ELISA, while the HPLC revealed exceeding of the MRL, with almost  $4 \mu\text{g}/\text{kg}$  sample (Georgescu M. et al., 2013). After a detailed assessment of performance parameters of HPLC and ELISA for OTA testing in pork kidneys, they conclude that on the background of extensive scientific debate over choosing the best OTA testing method in foods, HPLC adapted for animal derived foods is more indicated for OTA detection in pork kidney samples, than ELISA, as it has more precise results and a better repeatability. HPLC should be used for testing meat and organs, instead of ELISA, due to its better accuracy (Georgescu M. et al, 2013).

According to the CAC/GL 69–2008, re-validation may be needed if the hazard associated with a food or ingredient changes as a result of (1) higher concentrations of hazards than originally encountered and accounted for in the design, (2) a change in response of a hazard to control (e.g. adaptation), (3) emergence of a previously unidentified hazard, (4) new information indicating that the hazard is not being controlled to the level specified (e.g. new epidemiological findings or new validated and internationally accepted analytical technologies) or (5) a new food safety outcome.

In the light of this new information, on one hand it is reasonable to consider the need for re-validation of the control measures implemented within the food safety management plans for products manufactured from prime materials including pork kidney, now associated with the potential of being OTA contaminated. On the other hand, re-validation and re-verification is to be considered for the steps of the diagram flow that imply OTA analysis.

The case study presented in this paper approaches two example-final products that would cover both situations: (1) “toba”, which is a traditional Romanian meat product manufactured from pork meat and organs and (2) pork ham, a dried cured meat product. The assessment of appropriateness for re-validating and re-verifying of the steps which provide or

should provide measures for controlling the OTA contamination hazard were performed using the diagram flow of “toba” illustrated in Figure 1 and that which describes the technology of ham manufacturing, as shown by Figure 2.

The following tasks were followed prior to re-validation:

- Identification of the hazards that are intended to be controlled in the commodity taking into account all relevant information, including information from a risk assessment if available: the hazard was identified as OTA in the fresh organs (kidneys) used for “toba” manufacturing and production and accumulation of OTA at Drying/Ripening stage of ham diagram flow, in case of contamination of meat with toxigenic moulds.
- Identification of the food safety outcome required: maintaining OTA contamination below the critical limit of 15 µg/kg sample.

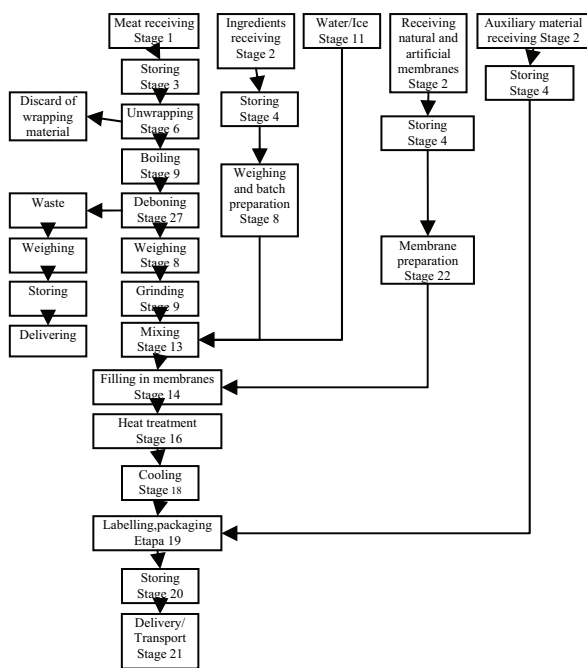


Figure 1. Diagram flow for “toba” (courtesy of Fox Com Serv S.R.L.)

It is reasonable that industry should determine if there are existing food safety outcomes or targets, established by the competent authority, relevant to the intended use of the food.

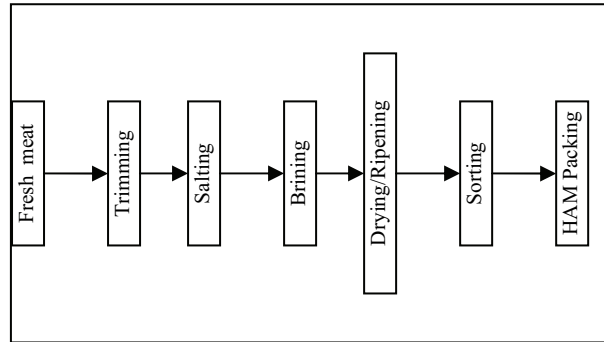


Figure 2. Diagram flow for ham (example generic product)

In the absence of food safety outcomes or targets established by the competent authority, targets were, consequently identified by industry, as appropriate. As stated by CAC/GL 69 – 2008, industry may also set stricter targets than those set by the competent authority. Considering that FBOs have the freedom of lowering the critical limits in the available regulations and in the light of the new relevant information discussed above on the tolerable daily intake set by EFSA and on the background of lack of MRL for OTA in meat and meat products, the critical limit of 15 µg/kg sample was considered the most appropriate for the best possible food safety guarantee.

- Identification of the measures that are to be validated/re-validated, taking into account the importance of the control measure in achieving control of the hazard to a specified outcome.

The control measures were the following: (1) zero tolerance for OTA contaminated organs at reception for “toba” and (2) special drying/ripening parameters in terms of water activity, visual observation and temperature for ham, as follows:  $aw < 0.9$ , zero tolerance for crack formation on product surfaces and temperature lower than 20°C. While for “toba”, there is no documented information on verification of OTA contamination of the prime material, the parameters used for the prevention of OTA formation at drying/ripening stage for ham production have already been validated as indicated by the literature (Dereje A.T. et al., 2011).

It is well known that validation activities may be resource intensive. Particular validation activities, such as testing for a contaminant in all prime materials at receiving, particularly when applied in an appropriate statistical

fashion, require significant resources. The extent to which sufficient resources are available and such activities can be undertaken will place limits on the ability to develop and validate food safety control measures that would be adopted by the industry in general. Therefore, until specific regulation are developed, OTA testing at receiving step for “toba” and similar products is to be considered by each FBO from the point of view of risk assumed versus financial resources invested.

CAC/GL 69 – 2008 offers a wide range of approaches for validating control measures, among which are: reference to scientific or technical literature, previous validation studies or historical knowledge of the performance of the control measure, scientifically valid experimental data that demonstrate the adequacy of the control measure, collection of data during operating conditions in the whole food operation, mathematical modeling or surveys.

After completing the tasks needed prior to validation, the process of validating control measures includes the following steps (CAC/GL 69 - 2008):

1. Decide on the approach or combination of approaches.
2. Define the parameters and decision criteria that will demonstrate that the control measure, if properly implemented, is capable of consistently controlling the hazard to the specified outcome.
3. Assemble relevant validation information and conduct the studies where needed.
4. Analyze the results.
5. Document and review the validation.

Results of the validation are therefore expected to demonstrate that the chosen control measure is capable of controlling the hazard to the specified outcome if properly implemented, and thus, could be implemented. In case the control measure is proven not to be capable of controlling the hazard to the specified outcome, it should not be implemented. In this case, a re-evaluation of product formulation, process parameters, or other appropriate decisions/actions should be performed.

The validation process of control measures for OTA contamination in case of “toba” based on

the diagram flow illustrated in figure 1, resulted in the following validation chart:

1. Pre-validation Tasks.
  - a. Hazard: OTA in the fresh organs (kidneys) used as prime material.
  - b. Food safety outcome required: maintaining OTA contamination below the critical limit of 15 µg/kg sample.
  - c. Control measure to be validated: zero tolerance for OTA contaminated organs at reception for “toba”.
2. Approach: based on the new scientific information (Georgescu M. et al., 2013), sampling of pork kidneys at receiving for OTA analysis using HPLC.
3. Parameters and Decision Criteria:
  - a. Parameters: OTA contamination of sample should be lower than 15 µg/kg sample, measured by HPLC.
  - b. Decision Criteria: samples that exceed the limit of 15 µg OTA/kg sample will be rejected and the supplier should be contacted.
4. Assemble relevant validation information and conduct the studies where needed.
  - a. Confirm incoming level of OTA in pork kidneys at receiving, for all batches.
  - b. Document all relevant information according to which no public health hazard will be posed by OTA levels of contamination below the limit of 15 µg OTA/kg sample (discussed above).
5. Analyze the results.
  - a. Data acquired by HPLC analysis of OTA levels in incoming pork kidneys (receiving step) should be analyzed and documented to ensure key operating parameters are being followed and the desired food safety outcome is achieved.
  - b. As appropriate, statistical analyses should be performed to assess the variability of the OTA level in pork kidney samples received at the facility for “toba” manufacturing.
6. Document and review the validation. All analyses, data, and decisions should be documented.

The validation process of control measures for OTA contamination in case of pork ham based on the diagram flow illustrated in figure 2, resulted in the following validation chart:

1. Pre-validation Tasks.
  - a. Hazard: accumulation of OTA at Drying/Ripening stage of ham diagram flow, in

case of contamination of meat with toxigenic moulds (the step is usually CCP for accumulation of toxigenic compounds due to the high risk of contamination with toxigenic moulds).

b. Food safety outcome required: maintaining OTA contamination below the critical limit of 15 µg/kg sample or preventing if possible the formation of OTA in this stage.

c. Control measures to be re-validated:  $a_w < 0.9$ , no crack formation on product surfaces, temperature lower than 20°C.

2. Approach: the parameters used for the prevention of OTA formation at drying/ripening stage for ham production have already been validated as indicated by the literature (Asefa D.T. et al., 2011). Verification will be performed by OTA analysis through HPLC, according to the new scientific information (Georgescu M. et al., 2013), on method performance for OTA testing in meat and organs.

3. Parameters and Decision Criteria:

a. Parameters:

i.  $a_w < 0.9$ , no crack formation on product surfaces,  $< 20^\circ\text{C}$ .

ii. OTA contamination of sample should be lower than 15 µg/kg sample, measured by HPLC.

b. Decision Criteria: facilitate a correct drying and ripening temperature, hold all suspected products and test  $a_w$  below 0.9, zero tolerance for crack formation while pressing; the meat samples that exceed the limit of 15 µg OTA/kg sample will be rejected and the supplier should be contacted.

c. Studies indicate that the applied control measures manage to maintain the OTA contamination under the maximum established limit of 15 µg OTA/kg sample (using the scientifically proven most appropriate method for OTA testing in terms of analytical performance).

4. Assemble relevant validation information and conduct the studies where needed.

a. monitor the performance of pressing machine in salting room, monitor the parameters for drying and the ripening temperature.

b. Document all relevant information according to which no public health hazard will be posed by OTA levels of contamination below the

limit of 15 µg OTA/kg sample (discussed above).

c. Verification will be performed by checking  $a_w$  of the products, by checking the temperature in the drying chamber and by random sampling for HPLC OTA testing, to control the type of moulds growing on the products periodically and if toxigenic test selected products for the occurrence of potential toxic secondary metabolites.

5. Analyze the results.

a. Data acquired by HPLC analysis of OTA levels in samples.

6. Document and review the validation. All analyses, data, and decisions should be documented.

## CONCLUSIONS

The results of assessment for the appropriateness of re-validation and rethinking of verification steps for the control measures of OTA hazard in two example meat products, in the light of new and relevant scientific information, revealed that thorough re-validation and rethinking of verification are strongly needed from the perspective of FBOs' responsibility in guaranteeing the safety of their final products. For "toba" meat product, OTA contamination was identified as a new hazard associated with the prime material at receiving stage, for the control of which re-validation assumed HPLC testing for OTA of all pork kidney received to an acceptance of OTA level up to, but not exceeding 15 µg OTA/kg sample. For pork ham the re-validation of already existing CCP for OTA at drying/ripening stage indicated the appropriateness of the control measures regarding water activity, crack formation and temperature in the context of applying verification through HPLC testing.

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