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CRITICAL CONTROL POINTS ON THE TECHNOLOGICAL FLOW OF PANIFICATION

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Rezumat. *Bread and panification products are intended for direct human consumption and underlying nutritional pyramid, it can affect the consumers health in case of biological, chemical or physical contamination, immediate or delayed, by noxious accumulation in the human organism. Only by rigorous compliance of the production rules throughout the technological process can ensure the quality and food safety of these products. If the risk can be prevented, eliminated or reduce to an acceptable level, as a result of a control actions made at that stage, it is considered a Critical Control Point (CCP). There can be checkpoints where it can exert a control action. Thus, the checkpoint is represented by any stage in which the risk factors, biological, chemical or physical, can be controlled in order to prevent, disrupt or reduce them to an acceptable level*.

Abstract. *Bread and panification products are intended for direct human consumption and underlying nutritional pyramid, it can affect the consumers health in case of biological, chemical or physical contamination, immediate or delayed, by noxious accumulation in the human organism. Only by rigorous compliance of the production rules throughout the technological process can ensure the quality and food safety of these products. If the risk can be prevented, eliminated or reduce to an acceptable level, as a result of a control actions made at that stage, it is considered a Critical Control Point (CCP). There can be checkpoints where it can exert a control action. Thus, the checkpoint is represented by any stage in which the risk factors, biological, chemical or physical, can be controlled in order to prevent, disrupt or reduce them to an acceptable level. This paper is referring to the control points on the technological flow of the bread fabrication, in all phases of this technological flow, laying stress on that points (or phases) which can affect security and food safety, through the influence of parameters of any kind on the quality of finished products*.

Keywords: Critical Control Point (CCP), panification, risks, preventive measures.

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1. Introduction

In the alimentary industry the quality assurance systems must be applied to ensure the safety and quality of the foodstuff, to maintain the confidence of consumers and for protect them by different types of contaminations. Can be applied various quality assurance systems such as Hygiene code, ISO (International Organization for Standardization), BRC (British Retail Consortium) and others, but most of all quality assurance systems most common, in panification, is HACCP (Hazard Analysis Critical Control Points). [1]

As a result of necessity of ensuring protection of consumers and fair practices in the international commerce, have imposed elaboration of some basic rules, to underlying innocuity of the alimentary products by the Codex Alimentarius Committee of FAO/OMS.

Before creating a HACCP concept, all hygienic weak links of the panification technological flow must be eliminated to ensure a good practice of manufacturing [2]

Every process has key points in which keeping under control of one or more parameters through measurement or observation provide the final characteristics of the products safety, in fact defined Critical Control Points (CCP). These points are identified on the technological flow route by a HACCP team, using the “Decision tree” proposed by Codex Alimentarius (figure 1) which contains a set of questions who will lead to the CCP.

The Decision tree is actually a set of questions that applies to each stage of process or for each product (ingredients, raw material, package or finished product) and for each identified risk. The answers to these questions certainly lead to the identification of a CCP.

The practice of applying the decision tree in the manufacture of bread showed that, depending on the specific conditions of production unit, CCP can be at: reception of the raw materials, internal transportation of the flour, stages of contamination, but also with possibilities of keeping under control by physico-chemical and microbiological analysis, measurements and periodical observation.

For identifying critical control points will be analyzed all stages of the technological flow, from the reception of the raw materials to the finished products.

Controlling the potential risks is achieved through:

- proper conduct of all phases of the technological process;
- analysis and risk assessment;

- establishment of preventive measures to keep contamination within acceptable limits, without dangers for the safety of products;
- application of the corrective measures that are imposed.

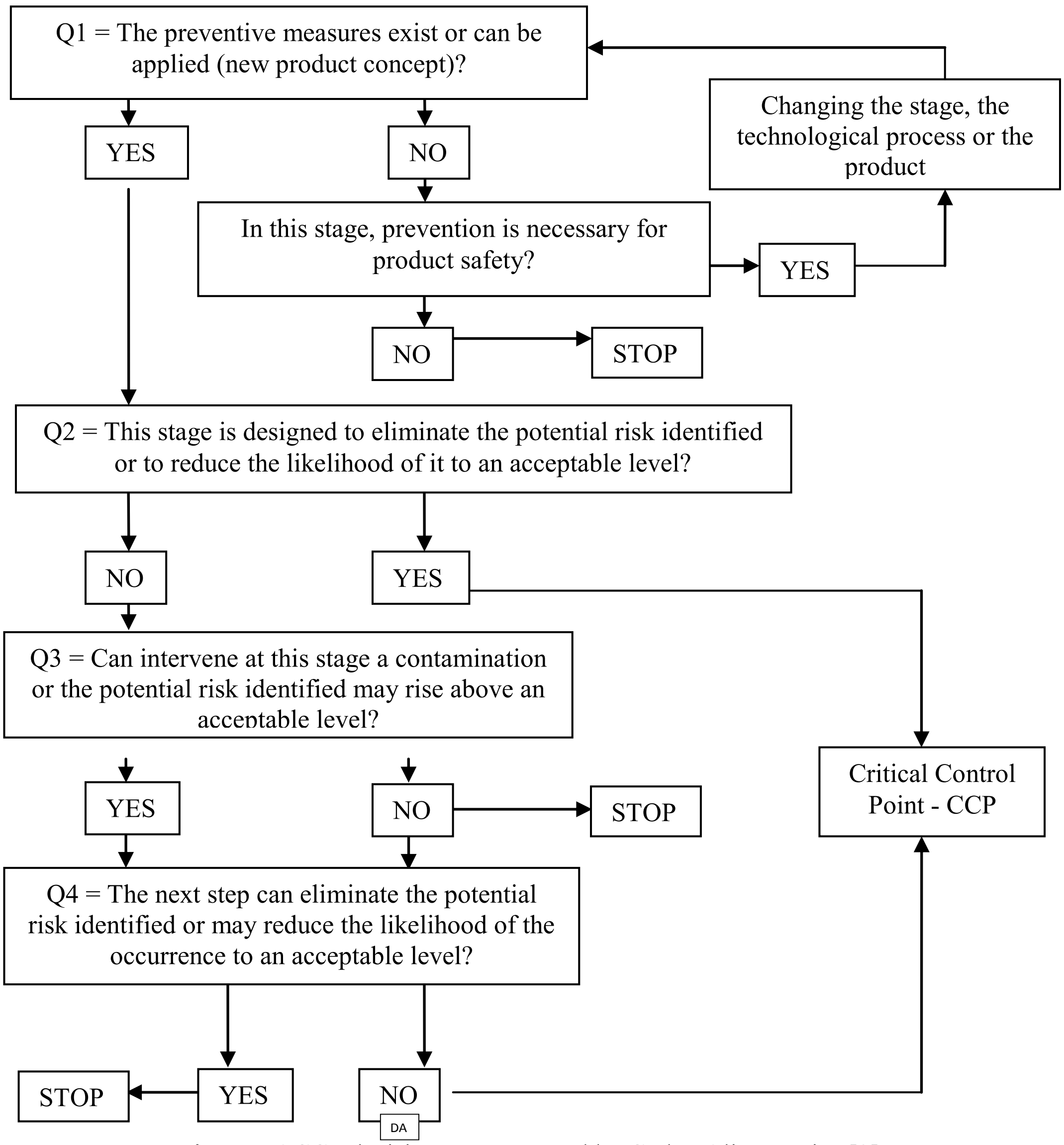

Fig. 1. HACCP decision tree proposed by Codex Alimentarius [3]

The risks of appearance of some contaminations are evaluated according to the severity and frequency of occurrence, noting as: Risk= G × F, where G is severity of the risk or its effect on the product and F is the frequency of occurrence or the probability of apparition of the risk.

The risks are usually marked with number from 1 to 4, where 1 means low risk and 4 means high risk, the latter is always a priority to remove or maintaining under control.

The severity represents the consequences that may occur on the health of a consumer due to its exposure to a contaminated food. This can be: high (a fatal consequence, severe illnesses, incurable damage with occurs immediately or after a period of time), medium (substantial damage or illnesses) or lower (minor injuries or illnesses without effect or with minor effects).

Frequency is the likelihood of having a contaminant in the finished product at the time of consumption and is classified into three levels: lower (theoretical risk or practically impossible), medium (may occur, it happens sometimes) and high (occurs systematically, repeatedly).

2. Analysis of critical control points that appear on the technological flow of white bread.

As shown in figure 2, for each operation from the panification technological flow is made a control. Critical points of this process intervene in operations of water thermostating, at the qualitative and quantitative reception of the flour, at the final fermentation of the batter and at baking. These are the four points that are considered CCP. Of course, each operation from the technological flow can influence the quality of the finished product, therefore each operation is provided with a control.

Therefore, further, we will analyze the four operations where intervene the CCP, as well as other operations that may influence the panification process and the quality of the finished products.

Quantitative and qualitative reception of the flour is the first CCP from the technological flow of manufacturing bread. What affects the quality of the bread, especially, is the attention with who is made the qualitative reception of the flour.

Packaging of the flour in milling facilities is usually made in sacks so that the quantitative reception in panification facilities is made by extraction of 5 to 10 sacks from the lot of flour and weighing of them, thus determining the average weight of a sack.

As can be seen, this is not a factor that can influence the quality of bread, but how the quantitative reception is made may influence the panification process, as well as finished product quality.

Qualitative reception of the flour is made for each lot, determining the quality of flour by laboratory tests of physico–chemical, organoleptic and bacteriological properties.

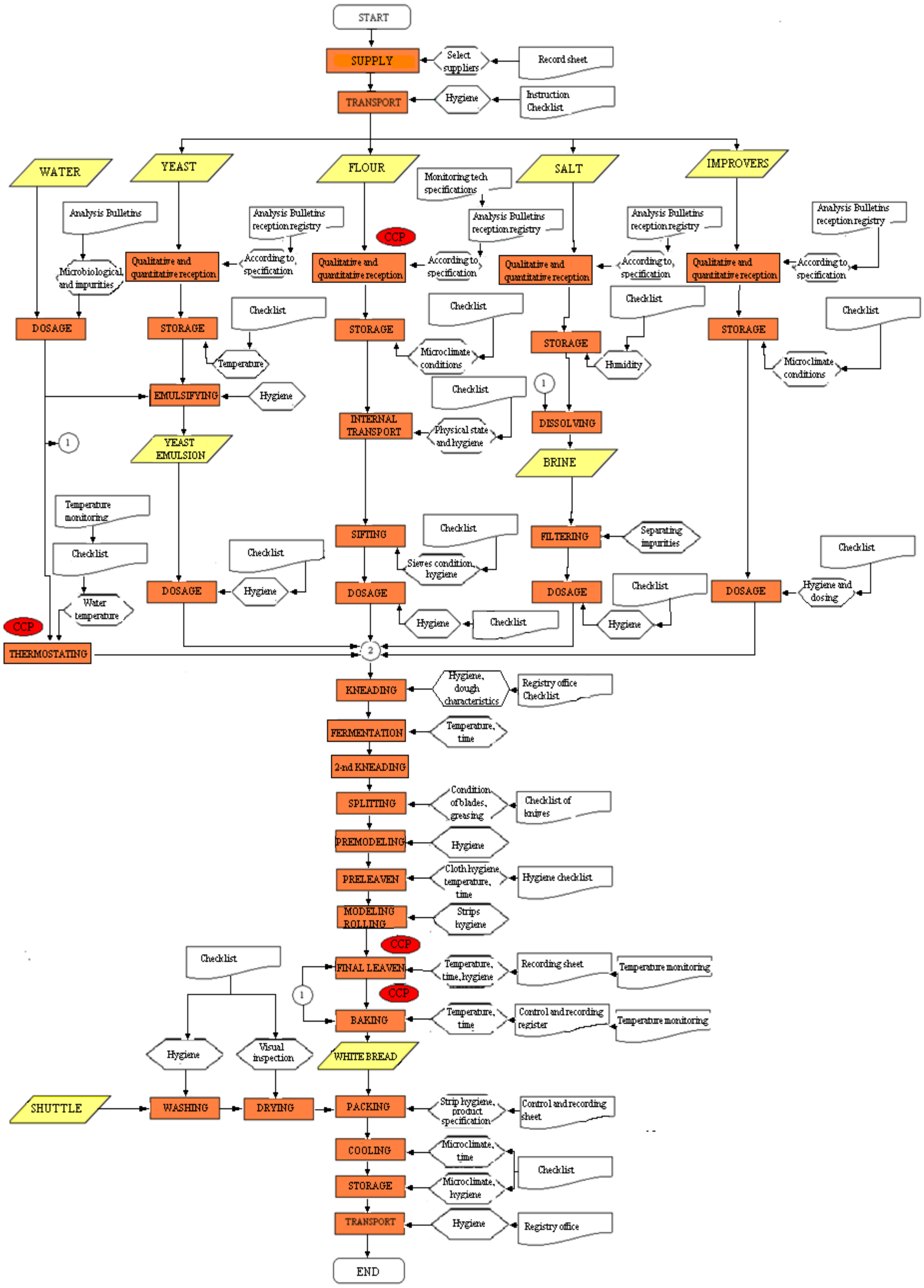

Fig. 2. Technological flow diagram for white bread [3].

From the organoleptic and physico-chemical properties of the flour are reminded:

- The color of flour – depends on the nature of wheat seeds, of how endosperm is separated from the shell, by content of coloring matters, by particle size of the flour and by extraction degree (the amount of bran left in the flour). In the panification process is necessary to examine the color of flour, on which depends the bread crumb color.
- The fineness of flour is determinate by the components particle size, that makes the flour to be soft when it has fine particles and rough (semolina flour) when it has large particles. Soft flour is not used in the panification process because the obtained batter softens quickly, and bread remains undersized.
- Humidity is an important feature of flour because directly affects the yield in bread, as well as finished product quality. After humidity the flour is classified in: dry flour ($u < 14\%$), average humidity flour ($u = 14–15\%$) and wet flour ($u > 15\%$). Optimal value of panification flour humidity is ranged from 13.5 to 14.5 %.
- Acidity of flour represents the number of cubic centimeters of NaOH 0.1n used to neutralize acids from 100 g of flour. Standards in force establish maximum permissible acidity for different extraction of flour: 30% extraction flour – maximum acidity of 2.2 degree; 75% extraction flour - maximum acidity of 3 degree; 85% extraction flour - maximum acidity of 4 degree.

Among the technological properties of flour that can influence the quality of bread are mentioned: the quantity and quality of gluten, hydration capacity of flour, ability to form and retain gas, starch gelatinization.

As potential risks of flour we mention: molds (risk of grade 3), Baccilus cereus (risk of grade 3), B. Mezentericus (risk of grade 4), pathogenic bacteria (risk of grade 3), mycotoxins (risk of grade 3), pesticides (risk of grade 3), heavy metals (risk of grade 3), metal chips (risk of grade 4), shards of glass (risk of grade 4), infestation (risk of grade 4). Risks assessed with grade 4 are priority to controlling or eliminating.

As preventive measures against potential risks above we have: procedures of selecting the suppliers, microbiological analysis at the selecting of suppliers and periodical for each supplier/quality reception according with technical specification/pest control instruction/baking test, periodic analysis, sifting with screening with magnetic system/sifting.

The second CCP from the panification technological flow occurs at the water thermostating.

Water used in the panification industry must meet the following conditions: be colorless, odorless and no taste, transparent, with a low content of iron and magnesium salts, because these salts close the color of the batter; be free of bacteria, because during the bread-making technology process these can't be destroyed, the core of bread temperature during baking only reaching 95–98°C; hardness does not exceed 18 degrees; to have a suitable temperature so that the temperature of the resulting dough is 27–30°C.

In the panification industry is not used boiled water and cooled, because through boiling water eliminates air whose oxygen is necessary to the yeasts activity and also is reduced the hardness.

Preparation of water for the panification process lies in warming to proper temperature for processing, provided in the formulation.

The water temperature θ_a, necessary to obtain a dough or a leaven with the temperature θ_m, respectively θ_{al}, is calculated using relationship:

$$\theta = \theta_{al} + \frac{F \cdot c_f(\theta_{al} - \theta_f)}{A \cdot c_a} + n \qquad [°C] \qquad (1)$$

where:

F, A are the quantities of flour, respectively water, used to obtain leaven or dough (kg); c_f, c_a – specific heat of flour, respectively of water (c_f =0.4 kcal/kg°C); θ_f – the flour temperature (°C); n – correction factor (n = 1 - summer; n = 2 - spring and autumn; n = 3 – winter).

In general, the leaven must have a temperature of 26–27°C, while the dough should have a temperature of 27–30°C.

In exploitation, water heating can be done using the heat achieved by burning a fuel separately or by the recovery of a portion of flue gas heat for the heating of the bread ovens.

If water temperature exceeds the prescribed temperature, then it is mixed with cold water, this is achieved by using water tanks equipped with automatic thermal – controllers, servo -valve and electro – valve for water preparation.

During operation of water thermostating can occur the following potential risks: microbial growth (risk of grade 3), iron oxides (risk of grade 3) and rock deposits or rust (risk of grade 4).

Against these risks may take the following preventive measures: water heating instructions, avoid stagnation of water at temperatures above 15°C, monitoring the water quality at the dispenser, use of pipe materials that do not rust.

The main purpose of leavening is the accumulation of carbon dioxide in the pieces of dough, that was removed almost completely (80%) in modeling. Here is the third CCP.

If the piece of dough would be introduced immediately after molding in the oven, would obtain a bread with low volume, compact core, very little loose, hard assimilated and a shell with ruptures and cracks. Gas formation should increase gradually over the final leavening and to reach a maximum at the time of introduction of dough in the oven.

In addition to panification characteristics of flour, dough composition and technological process of preparation, a great importance on the dynamics and intensity of gas formation it has the parameters of leavening space

Thus, the temperature of leavening space must be 30–35°C, humidity of 70–85%, and final leavening duration of 25–90 min, depending on the weight of the product, composition and consistency of the dough, flour quality and the degree of fermentation in vats of the dough. The average duration of leavening is by 30 min for products of 0.5–1 kg and 40–45 min for products of 1.5–2 kg. Facilities for final leavening can be with discontinuous or continuous functioning.

At the final leavening may occur the following potential risks: contamination from the bands (risk of grade 4), microbial growth (risk of grade 3), Bacillus mesentericus development (risk of grade 2), impurities from the leavening facilities (risk of grade 2), rust (risk of grade 1) and insects (risk of grade 2).

For final leavening phase the following preventive measures are required: checking bands hygiene, procedure for hygienisation, monitoring of the temperature and air humidity, correlation of leavening duration with these, cleaning leavening bands and enclosure of leavening facilities, verification procedure of the installation of steam and pest control.

The fourth and the final CCP occur when baking bread. Baking bread is a physical, biochemical and microbiological process caused by heating the dough – considered a colloidal body capillary-porous – and constitutes the transformation phase of the piece of dough into a finished product with an elastic core covered by a brown shell.

The mechanism of the process is conditioned by the way of penetration of the heat into the piece of dough – by conductivity, thermal-diffusion and diffusion of humidity, in liquid form and vapor – that successively change the energy state of different layers. In its turn, this energy state lead to microbiological, biochemical and colloidal transformation causing changes in volume and changes in the way of water binding, phenomena that influence each other and are specific only to bread baking process.

Thus, immediately after the introduction of the piece of dough in the oven, this begins to increase his volume, that at some point stagnate, the product keeping his volume and shape up to the end of baking process. The volume increase is due to carbon dioxide resulted from fermentation under the action of heat, which expands and tends to occupy a larger volume, loosen the dough.

In the same time the surface of the piece of dough is covered with a dry and thin film that is gradually turns in a crust which is thickens increasingly more. Also, under the influence of heat, the piece of dough lose water by vaporization, first through the layers from surface (which becomes rigid but keeping their malleability and elasticity) and subsequently from the inner piece of dough.

The water vapor from the inner layers of dough piece, came under the crust, can't get out easy trough small pores of the crust (much small compared with those of kernel) so that the water gather in area beneath the crust, she is warms and condenses on the colder layers inside the piece of dough, yielding latent heat of vaporization. These layers will warm, and the water will come again to surface and again will return and will condense on a layer of cold dough, but that will be more to the center of the dough piece. This shows that in the center piece of dough the temperature increases from crust to center, the zone of condensation progresses so, and the humidity decreases from crust to center. The phenomenon is called thermal diffusion of moisture. Note that the baking temperature and the moisture of piece of dough have an important role in the quality of finished product. Keeping their in normal parameters is priority; therefore baking is considered a CCP.

The most common potential risk, with a risk of degree 4, during baking is insufficient destruction of microorganisms; to combat this risk is recommended verification and monitoring optimum baking temperature. During baking operation can appear as potential risks these: metal chips from the band (little pieces of hearth) - risk of degree 3, rust (risk of degree 2), ash of flour or burns. It is recommended that preventive measures for these, checking the technical condition of bands or hearths (trays if is necessary) verification procedure of the installation of steam, verification of metal bands of the oven (or trays), instructions for cleaning bands (hearths, trays).

Conclusions

To keep under control the risks of infestation of biological, chemical and physical type of the finished product must be taken a series of control measures that we present below.

Control measures are that actions or activities which can ensure prevent or eliminate hazards on food safety or reducing them to an acceptable level.

Control measures can take various forms, from technical or technological solutions to organizational and procedural measures.

Control measures for the biological risks:

- Verifications to suppliers on quality raw and auxiliary materials
- Microbiological analysis of raw and auxiliary materials at reception
- Strict control at reception about the infestation or rodents attack;
- Ensuring the conditions of temperature and humidity of the air specific during storage for to ensure maintaining qualitative characteristics;
- Prevent contamination during storage by fighting pest;
- Use of raw materials and ingredients packed by methods and with materials adequate to prevent contamination or increasing the microbial load;
- Proper handling practices, which to protect raw materials, ingredients, semi-finished and even finished product by contaminations; avoid pouring from one container to another;
- The sifting of flour to eliminate the infestation;
- The monitoring of temperature, air humidity and the duration of the final proofing for prevent the increase of microbial load;
- The monitoring of heat treatments (ripening) from point of view of the temperatures and the durations for ensure besides the technological role of baking and the one of destruction or inactivation of the microbial load of contamination;
- Creation and verification of conditions for the personal and protective equipment hygiene and checking the health of personnel-periodically;
- Conducting the hygiene of utensils and equipment and verification by evidence of regular sanitation;
- Insurance of hygiene of production spaces, prevent infiltration, of dampness, of condensate;
- Insurance a good ventilation of production spaces for prevent the appearance of condensation;
- Staff training with correct operating and comportment practices;
- The microbiological control periodically of used water in the technological process;

- Use of clean packs for the transport of bread and bakery specialties;
- Hygiene control of vehicles

Control measures for the chemical risks:

- Verifications to suppliers (ex.: mycotoxins, pesticides);
- Physico – chemical analysis to raw materials, ingredients for those features with potentially toxic;
- Exigent organoleptic examination at reception to detect chemical substances contamination (ex. smell of insecticides, petroleum substances, etc.);
- The control of flushing utensils and equipment and surfaces that come in direct contact with the product after washing with detergent and/or disinfection with specific substances whose traces can be toxic;
- Storage of chemicals used to wash , disinfection, disinsection and derating under strict control, locked up and with limited access and controlled;
- Chemical control of water used in process;
- Control of additives dosages which may become potentially hazardous substances.

Control measures for the physical risks:

- Verifications to suppliers on the processing and control the flow of raw materials and ingredients;
- Exigent verifications at the reception for the lots of raw materials, ingredients and packaging;
- Proper storage to prevent contamination risks with pieces, plaster, sand, dust, rocks, wires, etc.;
- Using of magnets and corresponding sieves at sifting;
- Ensure waste disposal routes and compliance with them;
- Provide protective equipment without buttons or metal fixture;
- Staff training on rules of behaviour during activity;
- Controlling staff to follow the rules of conduct;
- Banning the use of glassware in the manufacturing areas (glasses, jars, cups, etc.);

- Ensure maintenance of equipment to prevent friction with the formation of metal filings and chips, contamination with wires, screws, plastic shavings, trimmings;
- Use of metal detectors for dough;
- Combating pest and birds in production or storage areas.

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R E F E R E N C E S

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