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HAZARD ANALYSIS AND CRITICAL CONTROL POINT (HACCP) IN THE PRODUCTION OF CHICKEN EGGS AND EGG PRODUCTS

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Abstract: The article presents data characterizing the specific nutritional feasibility of using chicken and quail eggs in human nutrition as a source of essential amino acids, vitamins, macro- and microelements, and other nutrients that determine their dietary properties.

Keywords: HACCP, Hazard Analysis and Critical Control Point, chicken eggs, quail eggs, protein, yolk, nutritional value, biological value, protein, fat, amino acids, vitamins, micro- and macro elements, lysozyme, digestibility, gastric ulcer, duodenal ulcer sanitary benignity, epidemic safety.

The HACCP system or Hazard Analysis and Critical Control Point System (management point) (in the Latin abbreviation HACCP “Hazard Analysis and Critical Control Point”) is a scientifically based system that ensures the production of safe products by identifying and controlling hazards. The HACCP system is the main food safety management system that has proven its effectiveness and is accepted by international organizations.

The HACCP concept covers all types of potential hazards that can affect food safety, i.e. biological, physical and chemical factors, regardless of whether they occur naturally for environmental reasons or due to a production process violation.

The harmonization of domestic and international food safety standards dictates the necessity of implementing procedures based on the principles of the HACCP system.

Basic principles of the HACCP system

1. Analysis of hazards (risks) through the process of assessing the significance of risks and their level of danger at all stages of the product life cycle.

2. Identification of critical control points (CCPs).

3. The objective of the critical limits of each CCP is to define a criterion that shows that the process is under control.

4. Development of a monitoring system to ensure that critical control points are monitored based on planned activities or observations.

5. Determining the corrective actions to be taken when monitoring results indicate a lack of management at a particular critical control point.

6. Development of a verification procedure to confirm the effectiveness of the HACCP system.

7. Documentation development for all procedures and records that comply with the HACCP principles and their application.

Risk analysis and assessment in egg production

A list of hazards that are important to consumers of poultry products and that are likely to cause harm or disease is developed from chicken rearing to egg packaging:

Hazards are divided into biological, chemical and physical ones, the dangerous factors of which are most likely to cause harm, injury or illness.

Chemical hazards include substances that can harm a person directly or over time, and can be formed in the product naturally or can be introduced from the outside during processing.

Biological hazards include harmful bacteria, viruses, parasites, and mycotoxins. Biological hazards are often associated with the raw materials used to make poultry feed.

Physical hazards include the possible inclusion of various physical particles

in the final product as a result of technology deficiencies from equipment, the environment, or other sources.

The main biological risk to food safety is the presence of Salmonella. Salmonella in feed is not considered a high risk to animals if it does not contain a serotype that is pathogenic to the species.

For poultry, S. pullorum, S. gallinarum or S. enteritidis are considered potentially pathogenic to layers. Nevertheless, all salmonellae are pathogenic to humans, therefore an effective food safety program is crucial to prevent outbreaks.

The feed mill should have an approved supplier program in place and weather conditions should be monitored for favorable conditions for mycotoxins.

While assessing the safety of feed, the type of storage should be taken into account. Feed stored in bins should be covered and not exposed to rain or humidity, which can lead to the development of pathogens or mold. Feed stored in bags should be kept in a pest-free environment.

Chemical hazards in feed can include pesticides that may be contained in feed, chemically generated dyes to color egg yolks, and the transfer of drugs. Ingredients must be inspected to ensure that the level of ingredients entering the feed mill meets FDA regulations.

While the ingredients are probably checked on a schedule, not at every load. Feed should be completely discarded from the containers and properly labeled so that there is no mixing of diets that may contain medications.

Considering the hazard analysis of the egg production and packaging process, it was possible to select points at which measurements and/or observations were made to confirm whether the technological process was indeed being properly controlled. These points in the technological process are called ***critical control points (CCPs).***

Critical control points are a stage of food safety at which it is possible and important to implement a control measure to prevent, eliminate or reduce a hazard to an acceptable level. The CCPs for chicken egg production are shown in Table 1.

Table 1.

Control point	Possible source of infection
Chicken coop	Insufficient cleaning and disinfection of fattening facilities before launching a new batch
Eggs / poultry	Insufficient or no disinfection of eggs. Infection of newly born chickens
Air	Lack of indoor air treatment (introduction of microbes through the air), possible contamination of ventilation systems with spores
Drinking water system	Contamination of drinking water with microorganisms and spores of microscopic fungi.
Feed	Contamination of feed by microorganisms
Straw bedding	Contamination of litter with microorganisms or fungal spores
Personnel	Bringing in of microorganisms by staff, suppliers or visitors (shoes, hands, work clothes) Transfer of germs from machines (wheels)
Rodents, insects	Transmission of microbes by mice, flies

In the HACCP system, critical values are based on factors such as temperature, time, physical size, humidity, acidity, salt concentration, odor, appearance, etc.

Setting critical limits - temperature limits for storage or pasteurization of eggs **(reduces the risk of Salmonella)**.

When the eggs enter the processing and packaging stage, the temperature of the eggs inside the line can range from 31.1°C to 35.6°C. At stand-alone processing plants where eggs are brought in from outside the territory, the initial internal temperature of eggs after tempering can range from 16.7°C to 20°C. These temperatures should be maintained throughout the cleaning cycle. Eggs that are detected as “dirty” are usually sent through the rewash line through the entire system. Raising the temperature of the egg due to repeated washing leads to an increase in the internal temperature of the egg, potentially causing increased risks.

Monitoring system (control over compliance with temperature storage and disinfection regimes). Before developing monitoring procedures, you need to determine the batch size. The lot size can be any size that the HACCP committee chooses. For example, one batch can be equal to one transportation load of eggs, one hour's production, or one day's production. The size of the batch affects the amount of suspect product. A suspect product is one that was created between the last

monitoring action during which it can be documented that the critical limit was reached and the monitoring action during which it was determined that the process did not reach the critical limit. In this case, it will be necessary to dispose of the suspect product or prove that the suspect product is safe.

Corrective actions (removal of the contaminated batch from the production process)

The HACCP team develops corrective actions for each CCP in advance, which can be applied immediately if monitoring indicates deviations from critical limits. For each critical control point (CCP), a **procedure should be developed for action in case of exceeding critical limits.** These measures include both correcting the situation - adjustments - and identifying and eliminating the cause of the non-compliance - corrective actions.

The first task of **adjustment** is to immediately restore control over the process and correct the situation (for example, extending the time of heat treatment of feed, restoring equipment operation). Another component of the adjustment is the separation of potentially hazardous products manufactured since the last positive measurement of parameters and the determination of the next steps to be taken with them. While the first task can be partially or fully foreseen and included in procedures or instructions (for corrective actions or monitoring) and can be performed by the employee who performs the monitoring in most cases, determining how to handle potentially hazardous products requires proper qualifications and authority of the performers. In other words, decisions on further actions with such potentially dangerous products should be made by qualified employees.

After correcting the situation **(corrective actions)**, it is necessary to prevent its recurrence in the future - to find the cause of the deviation and eliminate it. This also requires certain knowledge and responsibility of employees, so the procedure for implementing corrective actions in the CCP should contain not only a clear procedure for taking measures, but also distribute the roles and tasks of each employee involved in the process.

Documenting all cases of non-compliance and the measures taken is mandatory

for the purpose of their future evaluation.

Verification of the developed system (laboratory tests to confirm the effectiveness of HACCP at each stage of production).

The inspection plan should include a pre-shipment sign-off procedure that includes an inspection of each batch of product to determine that all conditions have been met before the packaged eggs leave the facility. Layer flocks are raised in different climatic conditions using different agricultural inputs and technologies, as well as on farms of different sizes. However, on poultry farms and small-scale producers, the number of birds kept is very small and, accordingly, the production systems and hygiene conditions may differ.

The hazards may differ depending on the type of production system. Within each egg-laying facility, it is essential to consider the specific agricultural practices that contribute to safe egg production, the type of product (e.g., unsorted eggs, eggs for the table egg market, eggs exclusively for breaking) and the production methods used.

The microbial load of eggs should be kept as low as possible using good egg production practices, taking into account the requirements for further processing. At the primary level of production, measures should be taken to reduce, as far as possible, the initial load of pathogens that affect safety and suitability. Improper procurement, production, and handling of animal feed can lead to the introduction of pathogens to chemical hazards such as pesticide residues and other contaminants, which can affect the safety and suitability of eggs and egg products.

Producers should take care, where necessary, during the production, transportation, preparation, handling, harvesting, storage and delivery of feed to reduce the likelihood of introducing hazards into the production system.

• In order to minimize the risk of hazards in feed, good procurement practices should be applied to feed and feed ingredients. This may include the use of supplier guarantees, contractual agreements, and/or the purchase of feed lots that have undergone microbiological and chemical analysis and are accompanied by certificates of analysis.

• Ensure that the feed is stored so that it does not become moldy or contaminated with waste, including feces.

• Since feed can be a source of contamination, heat or other treatment of feed should be considered to reduce or eliminate pathogens, including Salmonella.

• If the egg producer processes its own feed, it is important to keep information on the composition, origin of the ingredients, relevant processing parameters and, where possible, the results of any analyses of the finished feed.

Presently, only a small number of large poultry enterprises in Ukraine meet European product safety requirements. Large enterprises are those that have significant volumes of poultry production (monopolists in the industry) and are focused on both domestic and foreign markets, are ISO 9001 certified and have implemented the HACCP system. These enterprises mostly perform a full cycle of processing of their products, including the production of by-products such as egg powder, melange, etc. The final products are packaged and labeled to ensure traceability and expiration dates.

There are defined control points for product safety parameters and hazard prevention measures for small and medium-sized poultry enterprises producing food eggs. The data is presented in the form of a flowchart and a table specifying all critical control points with a description of the type of hazard, preventive measures, hazard monitoring methods and corrective actions. The flowchart of the production technology is one of the mandatory elements of the HACCP system implementation at the enterprise and is a graphical representation of a model describing an algorithm or processes in which individual production steps are displayed in the form of blocks of various shapes connected by arrows indicating the direction of material flows and the sequence of operations.

Challenge of creating a flowchart of production technology and its use according to the HACCP system:

1. Risk analysis. It is important to analyze food production in order to reduce possible risks to the safety of the products. This includes a thorough study of all production conditions - from receiving raw materials to storing finished products in

the warehouse. It is necessary to make a list of all production operations that are at risk.

2. Identification of critical control points in production makes it possible to find out the causes of potential hazards to determine ways to prevent and eliminate them. It is important to identify critical stages in the process technology that may affect the safety of the food product for the consumer.

3. Identification of critical limits of indicators for each CCP. Limit values are defined as criteria that separate the acceptable and unacceptable maximum or minimum values by which a biological, chemical or physical parameter must be monitored in the CCP to prevent, eliminate or reduce to an acceptable level the occurrence of a hazard in the food product.

4. Implementation of a CCP monitoring system for product manufacturing, namely, methods, tools and techniques for systematic measurement of control indicators. It is necessary to establish proper control over compliance with the permissible limits of fluctuations in the values of the measured parameters.

5. Implementing preventive and corrective actions. It is important to develop a set of measures to prevent and correct the process as necessary if the control data in any CCP exceeds the established acceptable limits. Preventive and corrective action procedures provide employees with clear instructions on how to address hazards.

6. Record keeping procedures. The introduction of a system of mandatory records of all documentation on production technology is linked to the developed flowchart, methods and actions within the framework of the enterprise's HACCP plan.

7. Procedures for checking the operation of HACCP systems (Verification). Verification (audit) should be carried out by qualified personnel who are able to identify inconsistencies in the plan or its implementation. Verification should be carried out at the end of the HACCP study; upon any change in the product, ingredients, process, etc.; in the event of a deviation; for newly identified hazards; and at regular pre-determined intervals. HACCP system verification is extremely

important to identify possible shortcomings in product safety and improve the HACCP system.

8. It is crucial that production employees actually master its methods to identify possible shortcomings in product safety and improve the HACCP system. In this regard, we regularly verify the workflow for its compliance with the technology and product safety requirements.

Egg products - melange and egg powder.

Cracked or dirty eggs that are not suitable for human consumption as table eggs should be sent for treatment (e.g., washing and breaking followed by microbiocide treatment) or disposed of in a safe manner.

• Broken/leaking eggs should not be used for the production of egg products and should be disposed of in a safe manner.

• Broken eggs can be used in egg products, but should be processed with minimal delay.

• Dirty eggs should be visibly clean before breaking and processing.

Other unsafe or unusable eggs should not be used for egg products and should be disposed of in a safe manner.

Egg melange is a mixture of egg whites and yolks (without shells) that is mixed, filtered, pasteurized, cooled and frozen at -18°C in metal cans of 5, 8 and 10 kg. The egg melange is stored frozen at a temperature of -9 to -10°C and relative humidity of 80-85% for up to 8 months. In industrial cooking, eggs are not a very convenient raw material because their shells are fragile, which makes them difficult to transport, and because of the shape of the eggs, there is a lot of air space between them, so they take up a lot of space during transportation and storage. Therefore, in the food industry, eggs are often replaced by a mixture of egg whites and yolks called melange, which does not have these disadvantages.

Melange is a semi-liquid mass of yellow or yellow-orange color. Frozen melange has a much longer shelf life than fresh eggs in the shell. The disadvantage is the high risk of microbiological contamination. Melange is used to prepare dishes that do not require separation of the yolk from the protein (dough products, omelets,

yarns, casseroles). To replace one 40 g egg, you need 40 g of mélange. Thaw the melange immediately before use in the amount required for the preparation of certain dishes, as it quickly deteriorates after defrosting. The jars with the melange are washed and thawed at room temperature or in water with a temperature not exceeding 50°C, then they are selected, opened, the melange is thoroughly mixed with a wooden spear, filtered and used immediately.

Egg melange – is a unique product that contains such fatty acids as linoleic, myristic and oleic. These components normalize the nervous and circulatory systems. 100 g of egg powder contains 11.5 g of fat, 12.5 g of protein, 0.7 g of carbohydrates. Calorie content is considered high: 100 grams of the product contains 157 calories. The melange provides the body with omega-3 and omega-6 acids, which play an important role in the cardiovascular system. Egg melange production: the first stage of egg melange production is automated egg washing, which is carried out under high pressure of disinfectant solution. Afterwards, they are sent to a cracking machine, where the shell and film are removed and the yolks are separated from the whites. The egg mass is mixed in a hopper. Next, it goes through a filtration process, after which it is produced in liquid or dry form. It is important that the equipment for making melange is made of stainless steel. It should be regularly cleaned and disinfected - the quality of the product depends on it.

Dry egg powder

Dehydration technology helps to extend the shelf life of the product. The drying process removes about 70 percent of moisture from the raw materials. This product is produced by spraying a liquid melange, after which it is packaged in special packages. This process can produce a dry mixture of yolk and protein or separate powders of these components. The final product is easy to use. It is stored in cardboard boxes, metal containers and plastic bags.

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