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Microbial spoilage of raw eggs in cottage level poultry farm

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Abstract :

In the hygienic territory area and healthy breeding conditions, the egg content is good enough for human consumption and free from microbes. But the egg shell surface can be contaminated by number of microorganisms, including the putative food spoilage microorganisms. Egg breaking systematically involves the contamination of egg white and egg yolk through contact with the spoiled shells, thus giving rise to highly perishable egg products. The aim of the present review is to propose a global overview on microbial spoilage of shell eggs. The spoilage characteristics, according to the type of the flora involved, and the methods already available for controlling, reducing or detecting spoilage events are described for eggs.

Key words : Bacterial spoilage; eggs; psychrotrophy; rotten egg.

Introduction:

Eggs have an excellent nutritive value. They contain 12-14 percent of proteins which are well balanced with respect to all essential amino acids. They are the excellent source of vitamin-A, vitamin –D, lipids and minerals. The content of shell eggs is generally sterile and is to be maintained in a fresh condition as far as possible. However, contamination occurs systematically during egg product processing, through the contact of the eggshells with the egg content at the egg breakage step. The content of newly laid eggs are usually free from contaminating organisms. During storage, microbial spoilage takes place. Micro-organisms may be drawn through the porous shell. The chances of microbial invasion are increased if the shell is dirty. Thus, the microbial contamination can lead to sanitary and/or spoilage problems. The sanitary problem mainly concerns *Salmonella* species, one of the most important agents involved in outbreaks in relation to shell eggs and egg products. Even if egg safety remains a key concern, the sanitary

risk has been reduced particularly through the improvement of hygienic practices in the breeding environment. However, microbial spoilage of egg and egg products can still lead to high economic losses. Preventing egg product spoilage represents therefore a real challenge in responding to the ever-evolving consumer demand for natural, safe, nutritious and tasty food. This article describes the spoilage characteristics due to the microbial flora involved in the spoilage of eggs.

Egg shell spoilage

The egg content can be contaminated during egg formation in the genital tract of infected hens, as well as after laying. After laying hens eggs are contaminated by the hen's faecal microorganisms, and by the flora of the environment of hen housing and egg conditioning centres. A diversified microbiota is involved, sometimes including pathogenic bacteria (essentially Salmonella Entertidis) and also food spoilage microorganisms.

The microflora of the egg shell is dominated by Gram-positive bacteria such as Staphylococcus, Streptococcus, Aerococcus and micrococcus. Other minor contaminations are Gram-negative bacteria such as Salmonella, Escherichia and Alcaligenes sp., and also Gram-positive bacteria such as Bacillus (De Reu et al, 2009; De Reu et al., Moats, 1980).

Depending on the study, the level of mesophilic aerobic microbiota on the surface of the eggshells ranges from 103.8 to 106.3 cfu/egg, with an average level around 104.5 cfu /egg (Moats 1980; Jones *et al*. 2004; De Reu *et al*., 2005; Musgrove *et al.* 2005). The dominating flora present at the eggshell surface is composed of Gram-positive bacteria; the contamination of the egg contents mainly involves Gram-negative bacteria.

It is recognized that bacteria involved in the spoilage of egg contents have the following characteristics:

(i) A high mobility facilitating penetration through the eggshell and the eggshell membranes,

(ii) Ability to resist the growth-inhibiting properties of the albumen, and

(iii) Various enzymatic activities leading to the breakdown of complex nitrogen and carbon sources present in the egg fluids, thus rendering this matrix suitable for supporting bacterial growth.

The main egg spoilage event is described as rotten egg, which appears as a coloured egg (black, blue, pink, red, green) mostly developing a rotten odour. The bacteria described as being involved are *Pseudomonas*, *Proteus*, *Alcaligenes, Enterobacter, Serratia, Stenotrophomonas, Cloaca, Acinetobacter, Moraxella* and *Citrobacter* spp. Other egg spoilage events are described as leading to a yellow pigmentation of the shell membranes, due to the action of *Flavobacterium* or *Cytophaga* species.

The relationship between the level of contamination of the eggshell surface and the occurrence of spoilage events is not obvious. Several predominant eggshell bacteria, such as *Micrococcus* and Aerobacter, are rarely found in rotten eggs. On the contrary, several bacteria, such as *Aeromonas* and *Proteus*, are found at low levels on eggshells, while they are amongst the highest occurring bacteria in rotten eggs (Mayes and Takeballi, 1983).

Factors influencing the contamination of shell eggs:

The spoilage of egg is related to eggshell contamination and the ability of some bacteria to penetrate the egg. The type and level of egg contamination of the egg shell surface are related to the hygienic conditions, breeding environment, the breeding practices, the housing system, the geographical area, and the season. Egg shell contamination is also possible during transportation or during packaging or at conditioning centre, either through the environment or from egg to another.

Intrinsic egg barriers have a strong influence on the invasion of the spoilage bacteria. Firstly, the cuticle, shell and shell membranes are barriers preventing the penetration of microorganisms from the surface into the egg content. The cuticle which is resistant to water and microorganism penetration may crack rapidly over time or during egg manipulation. The effectiveness of this protective coating is therefore, limited. The shell, a calcified proteic layer, represents a physical barrier but is rather ineffective because of the possible transfer of microorganisms through the pores, particularly if condensed water is present on the eggshell. The presence of eggshell cracks or micro-cracks increases the risk of contamination.

The external and internal shell membranes represent effective filters composed of anti-bacterial glycoprotein fibres, which may play a role in protection against penetration. In addition to these physical barriers, egg white, similar to an intracellular fluid, is an important line of defence against invading bacteria because it represents a not favourable environment for microbial development due to poor nutrient content, alkaline pH and high viscosity, and because it contains several molecules having antimicrobial activities, such as lysozyme, ovotransferrin, proteinase inhibitors and vitamin binding proteins.

Controlling, reducing egg spoilage:

Various techniques have been explored for the reduction of the level of eggshell contamination or for preserving or enhancing the natural defences of the egg itself. They include hen selection, improvement of the practices of breeding and farm management, and packaging, transport and storage of eggs production and management. Since the bacterial level on the surface of eggshells is related to the level of air contamination in the breeding environment, it appears crucial to limit dust formation and to promote good hygienic and building decontamination practices in order to prevent the spreading of microorganisms. The microflora and also the number of cracked or broken eggs, are related to the type of hen housing systems. The use of a nests and dust baths generally increases the incidence of dirty eggs and microbial contamination.

Attention should be paid in designing cages ensuring the best egg hygiene quality. The practices of egg collection on the farm, as well as the sorting, packaging, storage and delivery, must also be improved to reduce contamination. Cross-contamination must be avoided by preventing contamination of the staff and the environment. Egg decontamination practices could reduce the number of bacteria on the eggshell surface. Other ways of egg decontamination are being

investigated, such as pasteurization, "flash" treatment based on hot water or steam, ultraviolet (UV), ozone, irradiation, ultrasonic, electrolyzed water or ionized air (plasma) treatments (Baron and Jan, 2010). Attention should be paid in improving egg storage conditions, including temperature and duration conditions, both these factors being particularly involved in the preservation of the natural egg defences.. The storage of eggs at refrigeration temperatures is an effective way of reducing the liquefaction of egg white,

The presence of cracked or "flowing" eggs increases the risk of contamination. The egg conditioning step is hence critical. The integrity of the eggshell appears amongst the best defences against spoilage bacteria. In the packaging centres, egg candling is a key step for controlling the microbiological quality of eggs. Advanced technologies, utilizing computerized integrated cameras and sound wave technology, is also being applied for egg sorting. The use of UV light has been particularly efficient in detecting the fluorescent pigment due to the spoilage of the albumen by *Pseudomonas* (Elliot, 1958). Other methods have been developed for evaluating egg freshness (at research or industrial levels) namely sensory evaluation, physicochemical methods (pH, Haugh Units), infrared or front-face fluorescence spectroscopy, and other methods involving microwave sensors, and Nuclear Magnetic Resonance (Karoui *et al*., 2006).

Conclusions

Even if the pathogenic species, including *Salmonella* Enteritidis are under control in the egg product sector, there is a need to develop relevant methodologies for the control of spoilage bacteria, and particularly psychrotrophic and heat-resistant species which are potentially selected by the transformation and stabilization processes of liquid egg products stored at low temperatures. Nowadays, the establishment of sensitive and convenient methods, allowing for an early prediction of spoilage events, still remains a real challenge for the egg product industry and for the food industry in general

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