

Sanitizers and the Sanitization of Hatching Eggs

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The sanitization of hatching eggs is the backbone of the hygienic–sanitary management of eggs on farms and extends to the hatchery. Poultry production gains depend on the benefits of sanitizers. Obtaining the maximum yield from incubation free of toxic sanitizers is a trend in poultry farming.

Keywords: eggshells ; embryonic health ; hatchery ; hatching eggs ; microbiological safety

1. Introduction

In poultry, embryonic mortality from pathogenic microbial infection is preventable through simple, cheap and efficient preventive guidelines. In most countries, the sanitization of hatching eggs is the primary countermeasure to the attacks of pathogenic microorganisms on the embryo. Studies have shown that sanitizing hatching eggs with synthetic products such as hydrogen peroxide ^[1] and natural products such as clove essential oil ^[2] reduced the pathogenic microbiota in eggshells and increased the percentage of hatched chicks. These active materials are non-toxic, non-corrosive and non-damaging to the eggshell. However, unsatisfactory effects such as possible severe toxicity in embryos that led to their death were reported in eggs sanitized with formaldehyde ^[3]. Microfragments were found in the cuticle and the vertical crystalline layer in eggs sanitized with peracetic acid ^[4], and reduced hatchability was found in eggs sanitized with propolis ^[5].

The beneficial and non-beneficial effects of sanitizers in hatching eggs result from synchrony (favorable) or non-synchrony (unfavorable) factors, such as concentration and application time ^{[4][6]}. As mentioned earlier, it is clear that sanitizers, when applied to hatching eggs under certain conditions, can generate a repertoire of adverse effects that affect embryonic development. Embryonic health is undoubtedly an important aspect that influences the entire poultry sector. It is through a healthy embryo that a healthy chick will be born. In turn, if handled properly, this chick will become a healthy broiler that will reach the consumer's table without undue influence on human health. At the same time, the poultry chain experiences significant economic gains for maintenance and growth. However, no sanitizers should be definitively rejected before being fully and continuously evaluated unless the compound is known to be lethally toxic to the point that humans cannot manipulate it with personal protective equipment. Human health must be a priority over all matters considered when choosing a sanitizer for hatching eggs.

Formaldehyde is the primary sanitizer in the routine sanitization of hatching eggs on European poultry farms (for example, Germany and Poland), as well as in Brazil and Egypt, among other countries ^{[2][7][8][9][10]}. However, it has genotoxic and cytotoxic properties ^[11] that subject poultry farmers and chicken embryos to a high risk of hazardous chemical exposure and possible irreversible bodily harm. Indoors, a short exposure not exceeding 0.1 mg/m³ (0.08 ppm) of formaldehyde is recommended to avoid damage to human health ^[12]. Cadirci ^[13] reported that the concentration required to reduce practically 100% of the microbial load of hatching eggshells is at least 600 mg/m³ (489 ppm) of formaldehyde, which is an excessively high concentration when compared to those recommended for human exposure. Therefore, formaldehyde needs to be removed from the routine sanitizing of hatching eggs.

2. Sanitizers and the Sanitization of Hatching Eggs

2.1. Objective, Optimal Timing and Methods for Sanitizing Hatching Eggs

Egg contamination triggers an embryonic health crisis and threatens the world's poultry economy. This state of affairs can be alleviated by sanitizing hatching eggs, a relatively simple protocol in which the eggs must be submitted, soon after collection, to intervention in the high proliferation of pathogens in the eggshell and their possible mobility to the microenvironment of embryonic development, making the egg suitable for generating a chick. The ideal time to sanitize hatching eggs is up to 30 min after oviposition or collection (if it is immediate) ^{[14][15][16]}; otherwise, the probability of having no effect or worsening production results is very high. This is corroborated in ^[17], which reported improved

hatchability of eggs sanitized immediately compared with those sanitized six hours after laying, probably due to microbial penetration. In this protocol, the contact of the sanitizer with the eggs occurs through gaseous or indirect means and by liquid or direct means (**Figure 1**):

- Fumigation: the release of sanitizing vapors on the surface of hatching eggshells in an enclosed space.
- Spraying: the dispersion of a sanitizing mist on the surface of hatching eggs.
- Immersion: the act of immersing hatching eggs in sanitizer until there is an interaction between them.



Figure 1. Main methods of sanitizing hatching eggs.

The use of each method is based on the size of the production system, number of eggs produced daily, costs and availability of equipment and facilities, type of sanitizer, number of professionals involved in the process and the specific limitations of each method.

2.2. Formaldehyde

Formaldehyde (liquid or gaseous; also called paraformaldehyde-polymerized phase) has been linked to reduced eggshell microbiota and increased hatchability percentage. There are also reports that it did not affect any of these variables (**Table 1**). Nevertheless, it is also associated with reports of toxicity and permanent harmful damage to embryos and chicks when applied to hatching eggs (**Table 1**). Although these effects depend on the concentration, length of time and method of application of formaldehyde and the period in which the egg is exposed ^[13], formaldehyde itself is carcinogenic because it impairs and inhibits DNA repair ^[18]. Therefore, its use is unjustifiable regarding embryonic life safety, health and protection. Poultry production should value lower risks to bird life (whether during development or after hatching), which will benefit the highest priority condition of preserving human health. Given the possible future restrictions on using formaldehyde in the poultry industry, other sanitizers must be readily available and approved by competent bodies to meet the global poultry demand.

Table 1. Some reports of the effects of formaldehyde on hatching eggs.

Study (Reference)	Effect on Eggshell Microbial Count *	Effect on Hatchability *
^[19]	Non-evaluated	No effects
^[20]	No effects	No effects
^[21]	-	No effects
^[22]	Reduced	Increased
^[23]	Reduced	Non-evaluated
^[24]	-	Increased
^[25]	Reduced	Non-evaluated
^[26]	Reduced	No effects
^[2]	Reduced	Increased
^[27]	Non-evaluated	Increased
Study (Reference)	Some Reports of Adverse Effects on Embryos and Chicks	
^[28]	Underweight, underdeveloped and malformed embryos.	

[29]	Increased embryonic mortality in the early stage.
[30][31][32]	Reduced chick survival rate in the first post-hatch week.
[33]	Increased embryonic mortality in early, mid and late stages.
[34]	Reduced chick quality score as a result of slow activities and high number of unclosed navels.

* Effect compared to a negative control (non-sanitized eggs) and in the absence of negative control compared to the other sanitizers tested.

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