With sublimination dry litter and reduction of health problems

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The sublimation of a simple substance or of a chemical compound is its transition from a solid state to a gaseous state without passing through the liquid state.

In modern language this term is also generically used to indicate the opposite process, where the term de-frosting or inverse sublimation would be more correct.

At times, certain insects can be seen walking on water and as is known it is possible to make a metal clip (*Figure 1*) or a metal blade float, the surface of which is slightly oily, by placing them gently on the surface of the liquid.


Figure 1

These phenomena that seem to contradict the existence of the force of gravity and the principle of Archimedes can be explained considering the effect of surface tension.

Chemical compounds and simple substances can assume three different states (the so-called states of matter- solid, liquid and gaseous.

In the first case, the molecules are tightly bound together; these forces of cohesion make the solid compact, more or less depending on the material, and make it maintain its volume and its form.

In liquids the intensity of the forces of cohesion between the molecules does not ensure the compactness of the material: the liquids have their volume, but not their form, adapting to that of the vessel that contains them.

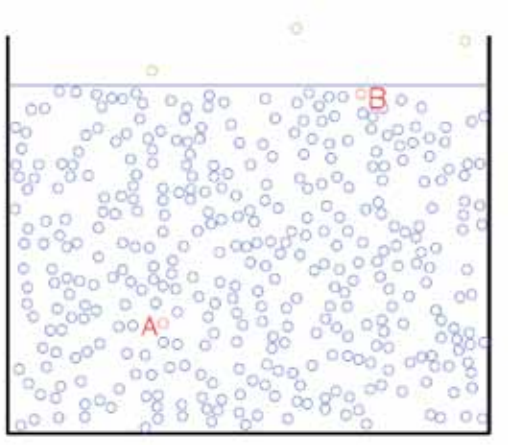


Figure 2

In gases, finally, the molecules are mutually much more distant from each other (approximately 10 times) compared to solids and liquids, thus for these substances, the forces of cohesion are negligible.

Figure 2 shows schematically and greatly enlarged the arrangement of the molecules within a liquid (the linear dimensions of the water molecules are approximately 0.3 millionths of a millimeter).

A molecule, such as the one indicated by the letter A is surrounded by other similar molecules that attract it. Molecule A, under the actions of these forces, will tend to move slightly in the direction of the closest molecule but on average will maintain its position over time.

In contrast, a molecule such as that indicated by the letter B, which is located near the surface of the liquid, will also be influenced by the attractive force exerted by the nearby molecules but these are only under or next to the molecule in question. It follows that the molecule B and all the other molecules close to the surface of the liquid are attracted more effectively towards the interior of this liquid.

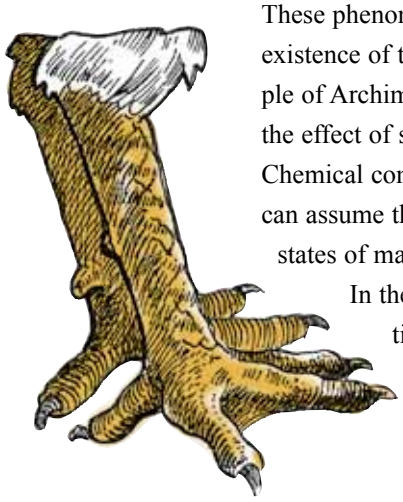
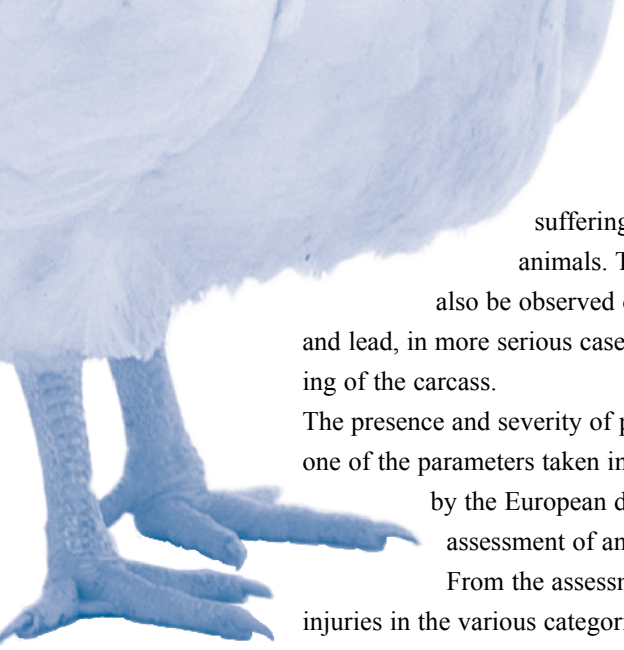


Figure 3

For this reason the liquid behaves as if there were an invisible film that was holding it together.
It is in fact the action of a molecular force which assumes the name of surface tension.
The intensity of the surface tension depends on the type of liquid concerned and on which other substance it is surrounded by.
Surfactants are substances which, when added to water, lower the surface tension. When the surface tension decreases, there is a lesser cohesion of the surface of the liquid.
Litter is an element of key importance in poultry farming. It is composed of different materials (usually straw or wood shavings), and its purpose is to insulate the animals from the floor, to absorb the moisture of excrements, to reduce contact with excrements, and through its fermentations to produce heat and to counteract or inhibit the development of pathogens.
The litter must always remain dry (moisture content of less than 50 %). Wet litter promotes the appearance of different diseases in addition to causing a reduction in animal performance. When the environmental conditions of rearing, and in particular of the litter, are not optimal, inflammatory phenomena in the skin of the foot and of the shanks of animals may emerge (*Figure 3*) and degenerate into real injuries, which may limit the movement and the ability to access food and drink and are a cause of



suffering for the afflicted animals. These injuries can also be observed on the breastbone and lead, in more serious cases, to a downgrading of the carcass.

The presence and severity of plantar injuries is one of the parameters taken into consideration by the European directive for the assessment of animal welfare.

From the assessment of plantar injuries in the various categories of commercial carcasses (light, medium, and heavy weight chicken) and in the various seasons, it has emerged that the incidence of injury is significantly higher in winter than in summer. Additionally, while in summer an increase in injuries can be seen in older birds, in winter the incidence of injuries is more stable across all three categories.

The different incidence of dermatitis in the two seasons must undoubtedly be viewed in relationship to the moisture content of the litter and in fact, litter removed at the end of a winter cycle contains on average of 50% more water than that of the summer cycles.

The moisture content of the litter is also closely linked to the development of the larvae as well as the fly of the *Alphitobius Diaperinus*, known as the meal worm, a 5-7 mm beetle that is dark brown in colour, with an average life span of one year (*Figure 4*). Larvae and adults flee from light, preferring dark places and wet litter. Although the adults have wings they rarely fly, but move about in sheltered areas mainly at night. In the arc of its life a female can produce up to 1900 eggs and from the egg to the adult they pass through several intermediate larva stages before reaching the pupal stage. Meal worms are a major problem in poultry farming, as they are a reservoir of many pathogens that can cause serious diseases such as Newcastle, Marek, Infectious Bursal, the virus of Avian Influenza, E. Coli, salmonella and certain tapeworms.

The chicks of broilers and turkeys are gluttons for them and they actively search for the larvae in the litter and eat them. In the first 10 days of life a small broiler can swallow up to 450 of them, while the turkey poult consumes up to 200, even though there is food available, and this causes a lack of homogeneity in the growth of the group.

At the beginning of the production cycle, the main concern is keeping the chicks warm. As the animals grow the common problem is excessive heat.

Animals convert feed and water into energy and they produce more heat than is necessary as well as a large quantity of moisture.

On average animals produce approximately 11.6 KJ/hour/Kg and the bigger they are the more heat they emit. For example 20,000 animals of 1.8 Kg add approximately 417,600 KJ/hour to the barn, the equivalent of two air burners working continuously.

The same group of animals can produce 3,750 liters of water per day, depending on the temperature.

During the brooding period the chicks need additional heat and combined with their growth the birds manage to keep warm, also heating the barn with the heat they produce.

The combination of temperature and relative humidity determines the level of animal welfare.

Chickens don't sweat, and their thermal homeostasis depends on evaporation through breathing, with an increase in respiratory rate, and also on the air that flows over them which collects and transfers their heat to the environment.

Figure 4

When the water evaporates, it transfers into the air in the form of water vapour with liters of water floating in the air.
When the air contains half of the water vapour that it could contain, it is said that the relative humidity is 50%. If instead it contains three quarters of its capacity, the relative humidity is 75%. When the air is saturated with water vapour the relative humidity is 100%.
The relative humidity indicates how much water the air can still absorb before reaching the point of condensation.
Warm air can hold much more water than cold air. Thus hot air, compared to cold air, can absorb much more water whether this comes from animals or from the litter.
This is the basic concept of winter ventilation. When the ventilation system brings cold external air into the barn this air is heated; in this way its relative humidity drops which means that its absorption capacity increases and it is therefore able to capture the moisture of the litter and take it out of the barn through the relevant extraction ventilation.
And here the ability of sublimation of the litter comes into play, seen from this perspective as an amorphous solid soaked in water, in which, in special conditions, the water present is transferred to the air in the form of water vapour.
Interference in the process of sublimation of the litter is now possible by introducing into the feed certain salified surfactant substances able to pass unaltered through the enteric tract which once removed with the faeces with an increase in the moisture of the litter are able to vary (decreasing it) surface tension, thereby facilitating evaporation through the sublimation process.
The result is the formation of a litter that is constantly dry, free from larvae and environmental pathogens.
If, despite the addition of surfactants, the litter should continue to remain wet, the cause must be sought either in the presence of chronic diarrheal forms, or, more frequently, in the incorrect management of the ventilation program.

Applications for livestock

Premise

Recent scientific studies in microbiology have permitted us to understand better the complex world of bacteria, focusing research on specific *chemical signs* that bacteria leave behind in their environment in order to communicate with each other. These chemical signs are tiny molecules called *autoinducers* (Katarina B. Xavier--Bonnie L. Bassler).

The complex system of cell-to-cell communication that occurs with the release of *autoinducers* and with which bacteria can interact with each other is triggered only when the microbial load exceeds a threshold called *Quorum Sensing*.

Practically, bacteria count themselves continually and when their census shows that they have reached *Quorum Sensing*, they begin to behave as a single colony.

The discovery of *Quorum Sensing* has shown us that microbial populations are not simple, more or less chaotic groups of microorganisms that each live on their own, but rather a coordinated community, inside which information flows continually and permits the community itself to resist adverse conditions, individuate the best habitats, adopt new development models, regulate competitive growth, control sporulation and make use of the capacity to act as a single complex and coordinated organism in order to improve and to implement the survival of the entire population.

Figure 5

The product was created with the goal of offering the animal husbandry industry a new way to handle the problems arising from animal waste products and to facilitate their management.

Breeding structure description

The breeding structure is composed of three levels and is made up of 6 boxes of 1,250 square meters each, perfectly symmetrical in a single body.

Box Number	Surface area
1	m^2 1,250
2	m^2 1,250
3	m^2 1,250
4	m^2 1,250
5	m^2 1,250
6	m^2 1,250
Total boxes 6	**Total surface area 7,500 square meters**

Each box is served by 4 watering lines and 2 feed lines.

Ventilation is transverse.

The litter is made of cutup straw.

There is no separate brooding area.

The boxes concerned are No. 2 (ground floor), No. 4 (second floor), No. 6 (third floor), and they are compared to box No. 1 (ground floor), No. 3 (second floor), and No. 5 (third floor) as control test boxes.

In this way, the full complement of three floors on one side of the structure and three floors on the other side were tested.

Trial Modality

- First dispersion in the preparation of the litter (paper already present).
- Second dispersion on the 15th day of the chickens' lives.
- Third dispersion after flock thinning.

Sampling Modality

The sampling of the litter was done under the supervision of the farming personnel within clearly defined points in the breeding environ-

ment: under the windows (Zone 1), under the extractors (Zone 2), under the watering troughs (Zone 3) and in the corners (Zone 4).
Samples were taken in (test) and in box 4 (treated).

Zone 1 one sample | Zone 2 one sample | Zone 3 three samples | Zone 4 two samples

Samples were taken on the 40th day of life and are 7 per box:
Samples were mixed in two separate containers and brought to the laboratory in order to be analyzed (The Institute for Experimental Veterinary Medicine of Lombardia and Emilia Romagna, Forlì section, Italy).

Research parameters

- Oocyst count
- Staphylococcus count
- Mesophillic aerobic bacteria load
- Enterobacteriaceae
- Fecal Streptococcus
- Molds
- Clostridia

Comparative parameters

Proof report No. 2012/246723 available the 31 of October 2012 -- I.Z.S. of Lombardia "Bruno Umbertini" Forli section

Parameters	Box 4 with Sublimation 40th days	Box 3 test 40th days
Oocysts	100/g.	300/g.
Staphylococcus	10,000,000 u.f.c./g.	20,000,000 u.f.c./g.
Mesophillic bacteria load	110,000x1,000 u.f.c./g.	500,000x1,000 u.f.c./g.
Enterobacteriaceae	200,000 u.f.c./g.	11,000,000 u.f.c./g.
Streptococcus	<100 u.f.c./g.	34,000,000 u.f.c./g.
Molds	200,000 u.f.c./g.	3,300,000 u.f.c./g.
Clostridia	80,000 u.f.c./g.	1,500,000 u.f.c./g.