Application of disinfectants in poultry hatcheries

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Summary: Veterinary control and routine sanitary procedures in commercial poultry hatcheries should include the following:
- choice of a suitable geographical location to ensure an isolated site;
- proper hatchery design with separation of major operations;
- one-way flow of work within the hatchery;
- adequate ventilation of each room;
- routine cleaning and disinfection;
- formaldehyde fumigation or alternative method for disinfection of eggs, equipment and incubators;
- a routine programme for monitoring microbial contamination levels within the hatchery.


INTRODUCTION

Hygiene is an important aspect of hatchery design and management. Good hygiene is required for maximum hatching rates and chick quality. The protection from contamination of hatching eggs and day-old chicks or poults, particularly in the light of specific disease controls (e.g. those concerning Salmonella), is becoming increasingly relevant in the operation of hatcheries. Protection of the workforce from contamination is also becoming a more prominent concern.

With the progressive development of the poultry industry within a country, hatcheries become larger in size, and many operate continuously throughout the year. This situation is the result of the large increases in the number of eggs set for incubation and hatched. To meet demand and utilise expensive equipment more economically, more than one hatching per week may be planned.

The marked increase in output of day-old chicks necessitates a corresponding increase in related services and operations. These services include the movement of personnel and vehicles within and around the hatchery building. All these factors demand precise planning of hatchery operations to ensure maximum sanitary standards. The work flow implicit in hatchery design supports the production of clean hatching eggs and the despatch of strong, disease-free chicks, which are the basic aims of poultry hatcheries.

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LOCATION OF THE HATCHERY

Many important points must be considered when choosing a location for a new hatchery. Easy access must be provided for eggs entering the premises from the breeder farms, for chicks being despatched to the growing houses and for the workforce.

An ideal site should be located away from a poultry population centre but close to a large village, and should satisfy the following criteria:
- good access to major roads, railways or airports, and good road conditions in the immediate area of the hatchery
- relatively inexpensive purchase of site
- good supply of labour at relatively low cost
- availability of services, such as electricity and water
- easy waste water disposal
- good possibility of low disease incidence.

A hatchery should be established or constructed at a safe distance from other buildings where poultry are kept. The hatchery should be surrounded by a fence to prevent the entry of non-authorised persons, vehicles and animals. When the site has been chosen, and conformity with the appropriate planning regulations has been ensured, the next consideration is the layout of the hatchery building (5, 6).

HATCHERY DESIGN AND WORK FLOW

The building must be designed for ease of sanitation. Rooms should be large enough to serve their allotted purpose and should be designed initially to provide for easy and cheap expansion. A designated arrival area is essential. The area for truck docking and egg arrival must be designed for the type of truck used to deliver the eggs. This area can be purpose-built for a flat-bed truck or for a truck with a tail lift. Hatchery layout should include physical separation of each major operation within the building. Thus each operation should be integrated, but not centralised into one unit. As far as possible, the movements involved in the production of chicks should be in one direction only. Cross-currents of air must be reduced to a minimum. The best results are achieved in hatcheries which have separate rooms for reception of eggs, fumigation, setting, hatching and removal of chicks. Washing facilities, storage rooms and offices must be separate (Fig. 1). Lack of adequate working areas and poor design of equipment and facilities make cleaning difficult, resulting in an unacceptable level of contamination. This contamination includes the microorganisms present in soil, feathers, litter, egg boxes and other items of equipment, including the clothing worn by hatchery workers. To reduce the exposure of the newly-hatched chick to these sources of contamination, the hatchery must be designed for efficient work flow. Thus, the hatching eggs must be moved through the hatchery in a methodical manner: from the receiving area, the eggs move to the room with the setting machines, then to the room with hatching machines, and finally to the chick boxing room and the loading dock. Subsidiary to this main flow of hatching eggs and chicks are secondary rooms or areas, for fumigation of eggs and washing of hatcher trays and movable equipment, and a room for storage of chick boxes and other equipment.
Example of hatchery design and work flow

All outside walls and the walls of the egg room should be well insulated to prevent sweating and condensation, which would provide fertile areas for bacterial and mould growth. Good lighting should be provided and wall outlets should be vapour-proof, allowing for thorough cleaning and proper sanitation. All horizontal exhaust ducts should be of circular cross-section, and should possess an adequate number of clean-out doors. Circular ducts are much easier to wash out than rectangular ducts.

Floor drains should be of the trough type, with floors properly sloped to the drains. Ceilings should be high enough to enable easy cleaning of the top surfaces of all equipment. High ceilings also allow air systems to move air above chicks and machinery, avoiding direct draughts. As ceilings require regular cleaning, they should be constructed of waterproof material. Adequate ventilation must be provided in all areas. As a hatchery requires an abundance of fresh air, mechanical air conditioning is recommended, but only where air-flow from one area to another section can be avoided. Roof-mounted heaters and evaporative coolers will provide the much-needed conditioned air. Air-moving equipment should be installed to avoid propelling air more than 50 yards (45 m) in any direction. This will provide a more constant temperature throughout each room. Wherever possible, each room should be ventilated separately, and the incubators and hatchers should be ventilated with air which has passed through a dust filter. The air from the hatching machines should be expelled from the building at a point where it will not affect incoming air. Generally, the following physical conditions and air movements are recommended (5, 17):

- Egg room temperature should be maintained at 19°C (67°F), with 25% relative humidity. If humidity is controlled at this level, there should be no cobwebs in the egg
room. Spiders will not build webs under these conditions. Fresh air should be provided at a rate of 0.06-0.10 m³/min per 1,000 eggs.

- Setting room temperature should be approximately 22-24°C (72-75°F), with a relative humidity of 45-60%. In this room, the air must be replaced in the setting machines at a rate of 0.15-0.20 m³/min per 1,000 eggs.

- The temperature in the hatcher room should be maintained at 24°C (75°F), with a relative humidity of 50%, and the rate of air movement should be greater (i.e. 0.40-0.60 m³/min per 1,000 eggs).

- Chick room temperature should be controlled at 22°C (72°F), with relative humidity at 50% to prevent dehydration of the chicks. The chick processing room requires the greatest air movement (i.e. 0.60-0.70 m³/min per 1,000 chicks).

In the summer or in warm climates, and in the absence of mechanical cooling, much larger volumes of air (about four to eight times more) will have to be moved. To facilitate hygiene control and ensure production of good-quality chicks, mechanical air conditioning is very useful because the air input and exhaust can be controlled accurately. The use of areas (setting machine rooms) with a positive air pressure facilitates correct air circulation and prevents entry of contaminated air from rooms or areas with higher microbial contamination.

**SOURCE OF CONTAMINATION AND PREVENTIVE MEASURES**

A major source of contamination within the hatchery is the poor sanitary condition of the hatching eggs on arrival at the hatchery. The level of cleanliness of the hatchery therefore depends to a large extent on the hygienic standards of the laying flocks and, in particular, on the regular and frequent collection of eggs. In each hatchery, it should be mandatory that only clean eggs be set. These eggs should be fumigated on the farm as soon as possible after collection to enable destruction of microorganisms before these have time to penetrate through the eggshell. The fumigated eggs must be packed in cases and ‘filler flats’ which are also free from dust and dirt. Hatchery personnel should adopt routine sanitary procedures, both in the hatchery and on the supply farms, to prevent the development of hatchery sanitation problems, rather than attempting to solve such problems after they have arisen. All outside hatchery doors should be kept closed and locked to prevent unwanted visitors from entering. Staff and authorised visitors should shower and change clothes (putting on hair nets, overalls, boots, etc.) prior to entry.

Contamination of the hatchery can also occur from the immediate environment. The spread of Newcastle disease virus from contaminated vehicles has been recorded. Consequently, the importance of locating the hatchery as far as possible from other buildings which house livestock, and poultry in particular, requires special emphasis. The disinfection of vehicles and outdoor equipment must also be an integral part of routine hatchery sanitation.

There are many areas in the hatchery where dust and dirt readily accumulate, e.g. the spaces between, behind and on the top of incubators and hatching machines. Dust and dirt can often be found inside air ducts. In hatcheries with poor ventilation systems, moulds and pathogenic bacteria (usually originating in the washing and disposal areas) can be carried by the ventilation system into the incubator rooms. Spores of moulds may
remain viable at room temperature for 18 months or more in hatchery dust. Embryos may become infected with bacteria and moulds during incubation, and newly hatched chicks are very susceptible to infection with various microorganisms (e.g. *Salmonella* spp., *Escherichia coli*, *Pseudomonas* spp., *Proteus* spp. and *Aspergillus fumigatus*) (18). Cracked eggs facilitate a marked increase in eggshell penetration by *Salmonella* spp. A single infected egg can contaminate large batches of clean eggs when the egg is accidentally broken, or as hatching occurs (29). Infection by *E. coli* can also occur in a similar manner (21).

As an example of the magnitude of the microbial problems which may be faced in a hatchery, it has been found that a single egg can carry up to 30,000 microbes on the shell. The increase in numbers of microorganisms inside the hatchery is aided by the relatively high working temperature and humidity.

The process of hatching and the work involved in removing chicks are accompanied by a massive increase in numbers of microbes, which originate from dead embryos, 'pipped' eggs, hatcher dust and fluff, and from the activities of personnel. These factors influence the level of microbial contamination of the chicks as they hatch, and affect their subsequent health and survival potential, especially during the first few weeks of life. The hatchery and the surrounding environment should be cleaned regularly.

Within the operating parts of the hatchery, the surface finish of floors, walls and ceilings must be 'hard', and suitable for washing by water applied under pressure. Similarly, the immediate surroundings of the building must be constructed of concrete or a similar impervious material, with adequate drainage. The drainage from inside and outside the hatchery must be designed to protect the environment from any pathogenic bacteria, viruses and moulds carried in the effluent.

**CLEANING AND DISINFECTION**

Effective cleaning and disinfection programmes are vital in the poultry hatchery. These programmes control key organisms, such as *Salmonella* spp., *Pseudomonas* spp., *Proteus* spp., *E. coli*, *Staphylococcus* spp., *Streptococci* spp. and *Aspergillus* spp. (16), and concentrate on four key areas of concern: the egg, surfaces which can contaminate the egg, air-borne contaminants, and movable equipment and personnel.

Washing is necessary prior to disinfection, as the presence of organic matter (e.g. soil, dust, feathers and litter) protects harmful organisms from the action of chemical disinfectants. In some instances, this organic matter will actually inactivate certain types of disinfectants. An adequate supply of water is therefore necessary for the cleaning of hatching areas and machines, the chick boxing area, and some permanent and movable equipment. Cleaning of floors, walls and equipment requires adequate and suitably-located drainage for waste water. Incubators must be cleaned after each transfer of eggs. This can be accomplished by scraping, vacuuming and mopping the floors, and wiping down wall areas and fan blades at the same time. Exterior surfaces require damp mopping at least once a week. The top surfaces of incubators should never be used for storage. Once yearly, each machine should be emptied and thoroughly cleaned. To avoid incubator contamination, eggs should be transferred before egg pipping starts.

Avoid moving or transferring chicks and cleaning hatchers at the same time in the same hatcher room. Cleaning should not begin until all chicks have been removed from
the hatcher room. Proper cleaning of the empty hatchers is necessary, after each hatching, to avoid contamination. Machines may be swept or vacuumed to remove loose debris. Use of a foaming detergent will aid in the removal of stains from the interior walls of the hatchers. Performed properly, scrubbing, rinsing and disinfection will yield a clean machine. Humidity wicking should be replaced after each hatching, and hatcher gaskets should be checked and replaced if necessary. Extra attention should be paid to fan blades, as dirty, rough blades cannot move the correct amount of air. Hatcher fan blades become easily worn, even in normal use, and should be replaced annually. A bent blade causes excessive vibration and does not move the air properly. Some fresh air from outside is necessary to aid the drying of the room and thus prevent the growth of mould and bacteria.

The air compressor should be located in a clean, dust-free room, as this air is channelled to all areas of the hatchery through hoses and humidifiers. Humidifiers in all areas must be kept sanitised to prevent the spread of harmful organisms. Evaporative coolers should be cleaned every week. Sumps on these coolers must be drained and scrubbed, and disinfectant should be added to the sumps when refilling. Heaters should be washed or 'blow-cleaned' to prevent dirt and dust from collecting.

All equipment must be properly cleaned and disinfected. Certain equipment (e.g. fibre egg trays and boxes) cannot be cleaned with water under pressure. Plastic egg trays, wooden egg boxes and plastic chick containers can be cleaned easily with water and detergents and, if necessary, these pieces of equipment may be given a final disinfection or fumigation. Another necessary precaution against the dissemination of disease agents involves labelling egg boxes and egg trays with an identification code, so that these may be returned to the flock which produced the hatching eggs when cleaning has been completed. Washer nozzles should be removed and cleaned frequently to ensure that these are in good working order. Washer pump motors should be switched off whenever filter screens are removed for cleaning, as running the pumps with the screens out allows debris to pass through the pump, blocking the nozzles. All flats, trays and racks should be wetted down and soaked for an adequate period prior to washing, thus enabling the washer to perform a more effective cleaning job. Water in the washer tank should be at 47-52°C (120-130°F) and should be changed frequently during the day to prevent equipment from being washed in dirty water.

An extra hatcher rack or 'dolly' in the washroom eliminates the need to stack trays on the floor at the exit end of the washer, thereby preventing re-contamination after washing. All washed trays and racks should be thoroughly disinfected before leaving the wash area. A water hose fitted with a common domestic spraying nozzle is suitable for this purpose. Clean trays and racks should never be put into a dirty hatcher room. Egg trays, setter trays or flats, and chick boxes must be thoroughly cleaned and disinfected before re-use or return to the farm.

Removal of hatchery waste is a very important consideration, and an efficient method of disposal must be planned. Vacuum disposal systems are now becoming fashionable, and space needs to be available for this equipment. Some areas within the hatchery do not lend themselves to the use of water under pressure, e.g. the top surfaces of incubators and hatching machines, electrical equipment and controls, ledges, tables and other horizontal surfaces. These surfaces readily collect dust and debris in which microorganisms multiply rapidly and should therefore be reduced to a minimum. The remaining horizontal surfaces must be cleaned regularly. For this purpose, a commercial industrial vacuum cleaner may be used. Disinfection may then be performed using a
disinfectant solution in spray form (13). For cleaning measures of this kind, an aerosol generator is useful. It follows from the above that routine fumigation alone is no longer sufficient. Nevertheless, fumigation using formaldehyde (formalin) has proved to be a very effective means of destroying microorganisms on eggs, egg cases, setters, hatching machines and fibre chick boxes, provided that these items have been subjected to preliminary cleaning.

FUMIGATION USING FORMALDEHYDE

Requirements for proper fumigation

The following requirements must be met if maximum germicidal activity is to be obtained from formaldehyde:

a) Temperature: the maximum effect is achieved in the temperature range of 24-38°C.

b) Humidity: this is essential for maximum effect, and a ‘wet bulb’ reading of 20°C or higher is recommended.

c) Time: the time required to kill the microorganisms depends on the temperature, the humidity and the concentration of formaldehyde.

d) Concentration: the use of potassium permanganate to liberate formaldehyde gas is desirable, as this produces an instantaneous expulsion of gas, giving maximum concentration.

To produce the fumigant, potassium permanganate should be mixed with formalin in a ratio (w/v) of 2:3. When the correct ratio of formalin and potassium permanganate is used, a dry brown powder remains after the reaction is completed.

Recommended application rate

An application rate of 53 ml formalin and 35 g potassium permanganate per m³ of space is recommended. These amounts are effective in fumigation for 20 min at the recommended temperature and humidity. To calculate the amounts of chemicals necessary, the internal dimensions (i.e. length × width × height) of the incubator, fumigation cabinet or fumigation room should be measured. The space occupied by trays of eggs or articles to be fumigated need not be taken into consideration.

Neutralisation of formaldehyde gas

Formaldehyde gas may be neutralised in 10-15 min using ammonium hydroxide at an amount equal to half the volume of formalin used.

Precautions

Formalin will lose strength unless maintained at room temperature in a tightly sealed container; it should not be stored for long periods, as a white precipitate (paraformaldehyde) will form. If this occurs, the precipitate should be thoroughly mixed in before use. If storage is necessary, formalin should be kept in small, completely filled containers. When mixing with potassium permanganate for fumigation, always add the formalin to the potassium permanganate, never the reverse. Formaldehyde at bactericidal concentrations is very irritating to the eyes, nose and throat. Hatchery personnel should use a respirator and avoid unnecessary exposure to the gas. An appropriate container should be used to release the gas. The sides of the container
should slope outwards to avoid an excessive build-up of heat, which could ignite the formaldehyde. The container should be made of heat-proof material, such as metal or earthenware, and should be sufficiently large to prevent the chemicals from boiling over. Chicks or poults should not be exposed to the full concentration of formaldehyde gas.

**Hazards of fumigation**

The human health risks of formaldehyde fumigation are a cause of great concern. Use of formaldehyde is prohibited in some countries. Human exposure should be avoided, and gas masks and protective clothing are essential (3).

**Fumigation of eggs**

To reduce microbial penetration of the shell to a minimum, eggs should be fumigated immediately after collection, and preferably while they are still warm. The fumigation room or cabinet should be airtight, and should be equipped with a fan to circulate the formaldehyde gas during fumigation and expel the gas from the building when fumigation is completed. The eggs should be collected loose in wire baskets or placed in plastic trays in a manner which will permit air circulation and exposure to the formaldehyde gas. The temperature and humidity should be at the recommended levels. The fumigation time should be at least 20 min. Experience has shown that fumigation for 60 min will not reduce viability of the eggs at hatching. The type of facility and fumigation procedure used with eggs, egg trays and cases at the hatchery is the same as for fumigation of eggs on the farm.

**Fumigation of eggs in setters**

Eggs should be fumigated within 12 h after setting, when the temperature and humidity return to normal operating levels. The setter doors and vents should be closed, but the circulation fan should remain in operation. After fumigation for 20 min, the vents should be opened to the normal operating position to release the gas.

Warning: Eggs which have been incubated for 24-96 h should not be fumigated, as this can result in embryo mortality.

**Fumigation of hatchers**

Following the removal of all chicks and the cleaning and disinfection of the empty machine, the disinfected egg trays are replaced and the machine is prepared for the next batch of incubating eggs. The doors and vents should be closed, and the temperature and humidity returned to normal operating levels. Fumigation time should be at least three hours, or preferably overnight, using the standard amounts of formalin and potassium permanganate.

Warning: The above fumigation procedure applies to a machine in which there are no eggs. Eggs and chicks cannot be fumigated using the above fumigation time.

**Fumigation of eggs in hatching machines**

Fumigation of eggs in hatching machines is a common practice in certain areas and under certain conditions. The eggs should be fumigated after being transferred to the hatching machines and before 10% of the chicks have begun to break the shell. After transfer of the eggs, the hatching machines are permitted to return to normal operating temperatures and humidity. The ventilators are closed and fumigation is conducted with the hatching fans switched on. The standard amounts of formalin and potassium permanganate are used. Fumigation time is 20 min.
Neutralisation of formaldehyde gas

Formaldehyde gas can be neutralised using a 25% solution of ammonium hydroxide; the solution should be applied at a rate of not more than half of the volume of formalin used. The ammonium hydroxide should be spread on the floor of the machine and the doors closed quickly.

Use of formaldehyde powder (paraformaldehyde) as a fumigant

Paraformaldehyde may be used as a source of formaldehyde gas for fumigating eggs and egg cases. This method is effective, provided that the temperature and humidity are at the recommended levels. The minimum temperature should be 24°C, with a wet bulb reading of at least 20°C. Paraformaldehyde should be used at a concentration of 10.5-13 g per m³. The conversion formula is 10 ml formalin to 2.5 g formaldehyde (paraformaldehyde) powder. The generator should remain in operation until all the fumigant is released. The door should be opened to allow the formaldehyde gas to escape, or the gas should be neutralised using ammonium hydroxide at a rate of 27 g per m³.

USE OF DISINFECTANTS

Ninety percent of hatchery sanitation is dependent on design of the premises, good management of the hatchery and of supply flocks, cleanliness, and a programme whereby dust is removed and prevented from reaching the hatching areas. The remaining 10% requires the additional hygienic measures provided by fumigation and disinfection (2). A disinfectant, whether used as a solution, gas or aerosol, cannot compensate for faulty cleaning or for a hatchery which is inadequately designed to permit a thorough cleaning programme. Hygiene control in a hatchery is essentially a result of cleanliness complemented by disinfection. To date, formaldehyde has been the fumigant recommended for use in hatcheries due to its efficacy and ease of application (12). However, the use of this product presents a serious hazard for human health and safety, and it is possible that the use of formaldehyde will be further restricted, if not prohibited, at some time in the future (4). Suitable alternative sanitisers must therefore be found for use in the hatchery environment, including for disinfection of incubating eggs. When eggs are properly washed, sanitised and dried, the level of bacterial contamination on the shell is greatly reduced. Inadequate egg-washing can allow microorganisms to enter the egg.

POSSIBLE ALTERNATIVES TO FORMALDEHYDE USE IN THE HATCHERY

Chlorine dioxide

Chlorine dioxide (ClO₂) is used in the poultry industry to clean ‘grow-out’ barns and hatchery equipment. Used as a foam, ClO₂ flows over the surface, trapping heavily soiled areas even on vertical surfaces (7). Hypochlorite solutions (containing 250-500 ppm Cl) have many uses in sanitation (1), but ClO₂ solutions containing only 30-100 ppm Cl are equally effective (8). As the concentration of chlorine is low and the chlorine vapours are trapped in the gas bubbles of the foam, this product is not
unpleasant to handle. ClO₂ does not appear to have detrimental effects on the eggshell cuticle, and this natural barrier to microbial penetration is therefore maintained (1). Hatching viability of chicken eggs is reduced when the eggs are dipped in ClO₂ solutions (40 ppm Cl) for more than 5 min, or in concentrations greater than 100 ppm Cl. However, treating eggs with ClO₂ foam (40 ppm Cl) has no adverse effect on hatching viability, while it reduces the number of egg-contaminant bacteria present (20).

**Phenolic compounds**

Phenolic compounds are effective sanitising chemicals against bacteria and fungi, but efficacy against spores and viruses is highly dependent on the concentration at which these products are used. Although (like chlorine-based chemicals) phenol-based sanitisers are relatively inexpensive, they are toxic to humans. Phenolic compounds are best used in the building in footbaths and as floor disinfectants.

**Quaternary ammonium compounds**

Products based on quaternary ammonium compounds are genuinely effective only against bacteria; action against fungi and viruses is highly dependent on the dilution, and these compounds have little or no effect on spores. Although these products are good detergents and are not toxic to man, they are relatively expensive. The best uses of quaternary ammonium compounds are in the disinfection of hatchery floors, walls and incubator trays, and in fogging. The application of a 3.0% concentration reduces aerobic bacteria counts on the egg surface (9).

**Iodophors, glutaraldehyde and peracetic acid**

Iodophors, glutaraldehyde and peracetic acid are all highly effective against bacteria, fungi, viruses and microbial spores. These are all relatively non-toxic products, but are expensive for use in large-scale operations.

**Ozone**

Ozone is an effective hatchery disinfectant (22). Both gaseous and aqueous ozone are capable of inactivating many poultry pathogens which routinely contaminate the surfaces of eggshells, setters and hatchers (26, 27, 28). Although the use of gaseous ozone has been shown to be effective in reducing microbial populations on the surfaces of hatching eggs, high embryo mortality resulted from over-exposure (27).

**Hydrogen peroxide**

Hydrogen peroxide (H₂O₂) has been used successfully for many years as a disinfectant, particularly as a surface decontaminant and steriliser in industrial and commercial sanitation programmes (24). Unlike formaldehyde, H₂O₂ is easily evaporated or destroyed after use (readily decomposing into water and oxygen), has no unpleasant lingering odour, and poses minimal safety problems for workers if handled properly. However, like any disinfectant, H₂O₂ should be handled with caution, as this strong oxidising agent can irritate the skin, eyes and mucous membranes, and can discolour clothing dyes and hair. Hydrogen peroxide is significantly less expensive to use than ozone, as it does not require on-site generation; H₂O₂ is effective at relatively low concentrations and has similar bactericidal activities to ozone. H₂O₂ (5%) compared favourably to formaldehyde as a disinfectant for incubating eggs, without adversely affecting hatching potential (23).
GENERAL RECOMMENDATIONS

A hatchery must be sufficiently isolated from risks of infection.

The hatchery and the premises must be designed and maintained to ensure that animals, rodents and wild birds are unable to enter.

Entry to the hatchery should be through a hygienic barrier (personnel should take a shower and change clothes).

Good hygienic standards should be maintained in the hatchery through an approved sanitary programme (regulation of temperature and ventilation; cleaning, disinfection and fumigation of eggs, rooms, installations and equipment, etc.). Re-contamination should be prevented by prohibiting movement of equipment or personnel from dirty to clean areas.

At any one time, the eggs in the hatchery should originate from one species of poultry only, and should be marked with the identification number of the breeding farm.

Any waste matter or refuse must be collected immediately and removed in an appropriate manner.

Hatchery workers should not be employed simultaneously in poultry processing plants, markets, or in poultry-raising or -handling operations.

Sexing and vaccination of chicks should be performed in a special room, equipped with a washbasin providing hot and cold running water and with the means to disinfect hands. Instruments and equipment used should be disinfected before and after use.

All data and activities must be recorded daily in the hatchery register or diary.

Chicks should be despatched from the hatchery in new, closed containers of disposable type.

Chicks leaving the hatchery should be conveyed in clean, disinfected vehicles which are used for this purpose only.

HATCHERY CONTROL AND MONITORING

The hatcheries should be visited by an authorised inspector (veterinarian) every three to five weeks, according to a schedule established in advance. The visits are made unannounced and on various working days. Special attention is paid to the proper application of all hygienic measures. The dates and other data regarding cleaning and the most recent disinfection of rooms, incubators, equipment, installation and other accessories are always noted.

When disease is suspected in a hatchery, the authorised person must be immediately notified, and samples of eggs, egg embryos and chicks should be examined.

Microbiological monitoring is an essential element of hygiene control in any hatchery and provides an evaluation of the hatchery sanitation programme. The use of a standard technique provides a comparative measure of the situation from year to year. The methods in use rely on determining the number of viable bacteria in the air within
hatchery buildings, on tables and other surfaces, and in the dust and fluff present at hatching time. It has been clearly demonstrated that microbial counts rise with increased activity in the hatchery (14, 15). A direct relationship has been observed between the air-borne population of microorganisms and the contamination of various surfaces. A variety of methods can be used in monitoring, depending on sample type and personal preference. One technique which has been used is the microbiological examination of fluff and dust collected from the hatching machine after the removal of chicks (31). Examination of dust and fluff samples has been used for the measurement of Salmonella spp. contamination in hatcheries (19). The plate exposure technique appears to be a simple method of monitoring hatchery sanitation. Tryptic soya agar plates are exposed for 10 min in various hatchery areas to obtain an estimation of total bacterial and mould contamination (11). The bacterial contamination of horizontal surfaces (e.g. tables and building ledges) and vertical surfaces (e.g. walls and doors) can be examined by pressing solid agar onto the surfaces. For this purpose, Rodac plates or elongated rolls of nutrient agar ('agar sausages') have been used (10, 25). Rodac plates should be made so that the surface of the agar is slightly higher than the edge of the plate. The cover of the plate should be removed and the agar pressed gently onto the surface to be monitored. The plate must not be moved in any direction once contact is made. The cover should be replaced after the impression is made; care should be taken not to touch the agar.

MICROBIOLOGICAL MONITORING OF HATCHERIES IN ISRAEL

Since 1972, a hygiene testing programme has been practised in Israeli hatcheries. This programme, based on periodic sampling of hatcheries and evaluation of their sanitary status, is described below.

Preparation of media for sampling

'Agar sausages' are prepared by adding 35 g agar powder, 2.5 g 'meat infusion broth' and 8 g sodium thiosulfate granules (or 5 g sodium thiosulfate powder) to 1 l of sterile water. The mixture is boiled until the ingredients completely dissolve (after approximately 1 h) and is passed through a separating tunnel before being poured into a sleeve of nylon membrane to make 'agar sausages', each 4 cm in diameter and 30 cm long. The 'agar sausages' are sealed at each end and then autoclaved for 20 min at 120°C before additional sealing and storage at 4°C.

Procedure in the hatchery

The test in the hatchery is performed routinely once a month. Samples are collected in each room from all kind of surfaces (e.g. floors, walls, tables, trolleys, egg trays, tops and interior of incubators, egg and chicken boxes, sexing and vaccination equipment, top of wash-stands, door-handles, switches, telephones and, very importantly, the surface of hatching eggs and the hands of personnel). The origin of the sampled eggs (parent breeding flock) is recorded. In every hatchery, twenty to thirty different areas and surfaces are sampled, and on each occasion three of the samples will be from the same place.
**Method of sampling**

At the start of sampling, three slices of ‘agar sausage’ (each approximately 0.3 cm thick) are cut and placed in a Petri dish as a test of sterility. This sterility test is repeated during the sampling procedure, and again at the end of sampling, to check that work is carried out aseptically.

The agar slices are cut using a knife which is dipped in 95% alcohol and then passed through a flame before each cut. Each sample is taken by pressing or stamping the cut end of the ‘agar sausage’ against the surface to be tested; the exposed end is then sliced off (to a thickness of approximately 0.3 cm) and placed in a Petri dish. On average, a total of 23-30 Petri dishes is used in a single hatchery test, hence 69-90 slices of agar are required (three slices in each Petri dish). The Petri dishes are wrapped in aluminium foil and refrigerated during transportation to the laboratory for incubation and assessment of the results.

**Reporting**

When the samples are sent to the laboratory for analysis, a report is enclosed, noting – in addition to the above-mentioned data regarding hygiene and disinfection – the areas where the samples have been taken. By using a form specially designed for this purpose, and by adopting code letters for the rooms and incubators tested, it is possible to record the data and the results of the laboratory tests with minimal administration and in a convenient presentation.

**Evaluation of results**

After incubation of samples at 37°C for 16-20 h, the number of bacterial colonies growing on each sample (each slice of ‘agar sausage’) in the Petri dish is counted and recorded. The average number is calculated by dividing the total number of colonies in the Petri dish by the number of individual samples in the dish, and a code or sanitation rating is assigned to each area in the hatchery sampled. Subsequently, an overall rating for the hatchery is calculated using the following code:

0 = no colonies present  
1 = 1-10 colonies  
2 = 11-30 colonies  
3 = 31-100 colonies  
4 = more than 100 colonies  
5 = too many colonies to count.

**Test for *Salmonella* spp.**

When the colonies have been counted, each Petri dish, with the agar slices, is flooded with selenite or tetrathionate broth and incubated overnight at 37°C or 43°C. *Salmonella* spp. isolation and identification are then performed using the usual procedures (30).

**Recommendation to the hatchery**

All results and the sanitary rating are recorded on the hatchery form, with reference to the areas sampled, and appropriate recommendations are considered for cleaning, disinfection or other actions at the hatchery.

Table I shows the sanitation rating (based on a standardised bacteriological technique) of hatcheries in Israel during the first years (1972-1977) and the last five
years (1989-1993) of sampling. As indicated, there has been an impressive improvement in sanitary conditions in the hatcheries over the years. In 1972, only 10% of the findings were classified as good (rating 1 and 2), a figure which rose to 99% in 1993.

* *

**TABLE I**

Sanitation rating of hatcheries in Israel

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of samples</th>
<th>Good (1 or 2)</th>
<th>Average (3)</th>
<th>Unsatisfactory (4 or 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First five years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>17,580</td>
<td>10.6</td>
<td>29.3</td>
<td>60.1</td>
</tr>
<tr>
<td>1973</td>
<td>23,580</td>
<td>43.0</td>
<td>48.8</td>
<td>13.2</td>
</tr>
<tr>
<td>1974</td>
<td>22,260</td>
<td>55.5</td>
<td>35.6</td>
<td>8.9</td>
</tr>
<tr>
<td>1975</td>
<td>28,500</td>
<td>66.7</td>
<td>26.1</td>
<td>7.2</td>
</tr>
<tr>
<td>1976</td>
<td>31,000</td>
<td>82.7</td>
<td>13.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Last five years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>27,800</td>
<td>94.4</td>
<td>4.7</td>
<td>0.9</td>
</tr>
<tr>
<td>1990</td>
<td>24,300</td>
<td>97.1</td>
<td>1.2</td>
<td>1.7</td>
</tr>
<tr>
<td>1991</td>
<td>26,580</td>
<td>97.8</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>1992</td>
<td>21,780</td>
<td>98.1</td>
<td>1.1</td>
<td>0.5</td>
</tr>
<tr>
<td>1993</td>
<td>22,080</td>
<td>99.0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**UTILISATION DES DÉSINFECTANTS DANS LES COUVOIRS.** – Y. Samberg et M. Meroz.

**Résumé:** Le contrôle vétérinaire et les opérations sanitaires de routine dans les couvoirs commerciaux devraient bénéficier :
- du choix d’un emplacement géographique propre à garantir l’isolation du site ;
- d’une conception appropriée du couvoir, permettant la séparation des principales opérations ;
- d’un déroulement des opérations à sens unique à l’intérieur du couvoir ;
- d’une ventilation adéquate dans chaque pièce ;
- d’un nettoyage et d’une désinfection de routine ;
- d’une fumigation au formaldéhyde (ou d’une méthode alternative) pour la désinfection des œufs, du matériel et des incubateurs ;
- d’un programme de routine permettant de contrôler les niveaux de contamination microbienne à l’intérieur du couvoir.

USO DE DESINFECTANTES EN LOS LOCALES DE INCUBACIÓN. – Y. Samberg y M. Meroz.

Resumen: El control veterinario y las operaciones de saneamiento de rutina en los locales de incubación comerciales deberían contar con:
- la elección de una situación geográfica que garantice el aislamiento;
- una concepción apropiada de los locales que permita la separación de las principales operaciones;
- un flujo de operaciones lineal y en un solo sentido dentro de los locales;
- una ventilación adecuada en cada pieza;
- limpieza y desinfección de rutina;
- fumigación con formaldehído (o un método alternativo) para la desinfección de los huevos, el material y las incubadoras;
- un programa de rutina que permita controlar los niveles de contaminación microbiana dentro de los locales.


* * *

REFERENCES


