

EVALUATION OF TWO DISINFECTION PROGRAMS IN DISINFECTING POULTRY HOUSES UNDER FIELD CONDITIONS

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ABSTRACT

Received at: 27/11/2013

Accepted: 26/11 /2014

An evaluation of the efficacy of the use of either formaldehyde (10% formalin) or peroxygen commercial products in disinfection of battery cage poultry houses was estimated under field conditions. For this purpose, swab samples were collected from three different sites and from drinking water dispensers from four battery caged broiler and layer houses before and after cleaning and disinfection. Also, water samples were collected from the original well water source and the storage water tanks (main and houses storage water tanks) before cleaning and disinfection. Total colony counting was used in the evaluation of both swabs and water samples followed by bacteriological examination for identifying the contaminant bacteria. The results of the examination of water samples revealed that in spite of sterility of original water source there was sever contamination of the stored water in the storage tanks with different types of pathogenic contaminant bacteria including *Staphylococcus aureus*, *E.coli*, *coliforms*, *Pseudomonas earuginosa* and *Proteus spp.*. The same contaminant bacteria were isolated from the swab samples in addition to *salmonella typhymurium* contamination which was isolated from batteries and floors of both broiler and layer houses. On the other hand, both the tested disinfectant products were significantly effective ($p < 0.001$) in decline the viable total colony count from different sites of each house and from drinking water dispensers from either broiler or layer cage houses with depletion percentage reached 99.999% but the use of formaldehyde product failed to overcome the pathogenic contaminant bacteria except for *salmonella typhymurium* contamination. The efficiency of the disinfection was more effective in broiler houses than in the layer ones. On conclusion, a high standard planning of cleaning is of great importance before the application of the disinfection process and the correct usage of disinfectants in addition to, an effective program of eradication of rodents and insects should be applied is important for a successful disinfection and biosecurity program. Also, the obtained data highlights the emergence of the necessity of improving farmers' and hygiene specialists' education on the use of disinfecting products in poultry houses. It was recommended to use more environmental friendly safe and efficient disinfectants as peroxygens to be alternative to the use of formaldehyde in disinfection of poultry houses which may soon become illegal in some countries due to its health hazard and environmental concerns.

Keywords: *Efficacy, Formaline, Disinfection program*

INTRODUCTION

Current proposals for a new Animal health strategies and new industry guides for good hygiene practices in broiler and layer production (Anonymous, 2008; Anonymous, 2010) should have special biosecurity program including effective cleaning and disinfection. The effectiveness of on-farm biosecurity use of reliable disinfectants for housing, drinkers and feeders which is of fundamental importance to these control measures, particularly in all-in-all-out systems.

A biosafety program consists of actions and measures aiming at improving poultry hygiene and health

during the production process (COBB, 2003). This program becomes stricter as it goes up the pyramid of broiler production, from commercial farms to pure breed farms (Lauandos *et al.*, 2005).

Disinfectants are important components of a biosecurity program. The objective of disinfection is to reduce microbial populations (Eckman, 1994). One of the most effective methods to reduce the level of pathogens includes the application of proper management and husbandry practices, such as all-in all-out system (Wierup, 2000) and regular cleaning and disinfection, especially before introducing a new flock to the farm (Doerning, 1998). The choice of disinfectants is critical in establishing a successful

sanitation programs not all the disinfectants are effective against the major pathogens that cause economic diseases in poultry (Rodgers *et al.*, 2001). Glutaraldehyde and formaldehyde are known to alkylate and create cross-links within protein molecules and to bind to cell wall peptidoglycans. Formaldehyde also forms DNA protein cross-links. It acts principally via damage to the cell envelope. Aldehydes, especially formaldehyde, are not readily inhibited by organic material (Gorman *et al.*, 1980). Peroxygens are another group of oxidizing agents, generally using peracetic acid to disrupt lipid membranes, proteins and nucleic acids via attack by reactive species such as the hydroxyl radical $\cdot\text{OH}$. Peracetic acid is active in the presence of organic debris (McDonnell and Russell, 1999), although such material reduces the effect of all the oxidizing disinfectants owing to consumption of the active chemical species by reaction with organic matrices (Chapman, 2003; Russell, 2004). Different disinfectants will be affected to different extents by characteristics of the diluting water, the organic debris, the physiological state (including nutrient and moisture stress) of the pathogens and the nature of the surfaces involved (Brown *et al.*, 1991; Davison *et al.*, 1996; Bessems, 1998; Ward *et al.*, 2005).

The aim of the current investigation was to study the efficacy of two disinfection programs after common cleaning in both battery cage broiler and layer houses and to study the effectiveness of two different used commercial disinfectants in the efficiency of the biosafety program under field conditions. Also to study the possibility of use of environmental friendly disinfectants as alternative to health threaten one.

MATERIALS and METHODS

Disinfection Products:

Three commercial disinfectants products were used and were diluted according to the manufacturers' recommended working concentrations:

1- Disinfectant (1): a 10% (vol/vol) commercial formalin dilution of the standard 37% commercial dilution, was applied by fogging using a high-pressure washer to run-off point

2- Disinfectant (2): Peroxygen products consist of 2 commercial products:

A- Degaclean 51(peroxyacetic acid 5%, hydrogen peroxide 26% and acetic acid 6%-7% evonik products-Germany) used in removing of organic matter and biofilm before disinfection of poultry houses. Applied by spraying into the apex of the roof and work down the walls to the floors under pressure of 5-10 ml/l according to the intensity of organic matter up down and left for 30 minutes then drained with water.

B- Peraclean 15 (consisted of peracetic acid 15%, hydrogen peroxide 22% and acetic acid 15%-18% - evonik products-Germany) applied in concentration of 5-10ml/l by spraying into the apex of the roof.

Method of disinfection:

Method (1): application of 10 % (vol/vol) commercial formalin dilution of the standard 37% dilution.

Method (2): Disinfection using Degaclean 51 (step 1) followed by Peraclean 15 (step 2) according to the manufacturers' recommended working concentrations.

Table 1: The used chemical disinfectants and the used dilutions.

Disinfectant	Dilution	Supplier	Active ingredients
Formalin	10% (vol/vol) formalin dilution of the standard 37% commercial dilution		Formaldehyde
Degaclean 51	5-10ml/l applied by foam spraying	evonik products-Germany	peroxyacetic acid 5%, hydrogen peroxide 26% and acetic acid 6%-7%
Peraclean 15	3ml/l	Evonik products-Germany	consisted of peracetic acid 15%, hydrogen peroxide 22% and acetic acid 15%-18%

Disinfectant Evaluation:

For evaluation of the two commercial disinfectants, swab samples were taken from different sites of both cage broiler (4 houses) and layer chicken houses after getting rid of the last flocks of broiler and laying hens that were suffered from sanitary problem. (4 houses) before cleaning and disinfection. Prior to disinfection,

all houses were washed by soap and water, and scraping the organic materials by different scraping tools manually then rinsed by water using a pressure washer and allowed to dry. Half the numbers of each house type (either broiler or layer) were disinfected using method (1), while the remaining houses were disinfected using method (2). In all cases the

disinfectants were applied to all surfaces of the houses. Houses were restocked 1 day after the disinfectants had dried out from the house surfaces.

Sample collection: A total of 240 swab samples were collected from the walls, batteries and floors of battery cage broiler and layer houses (ten swabs for each place in each house) on sterile saline solution before and after cleaning and disinfection of the tested houses. Also, water samples were collected from the original drinking water (well) source (1 sample), the main storage drinking water tank (1 sample) and the poultry houses storage drinking water tanks (8 samples) in addition to 80 swab samples were collected from water dispensers of the examined houses (10 swabs per house) before cleaning and after cleaning and disinfection of the tested houses. The collected samples were placed in a cooler box with ice packs (4-10 °C) and transported immediately within few hours (not exceed 24 hours) to the bacteriology lab of Poultry Diseases Department - Animal Health Research Institute - Dokki - Giza to be subjected to bacteriological examination.

Examination of the collected samples:

1- Total colony count (T.C.C.): Using poured plate technique method, 10-fold dilutions of each water and swab samples was used for determination of total bacterial load, on brain heart infusion agar (APHA, 2005). The plates were incubated for 1-2 days for fast growing bacteria at 37°C (APHA, 2005). The different isolated bacterial colonies were further identified according to Dufour-zavala *et al.* 2008.

2- Bacteriological examination of the collected samples: Samples collected for bacteriological examination were inoculated in peptone buffer, brain heart infusion broth (oxid) and selenite-F broth (oxid) then incubated at 37 °C for 24 hours. A loopfuls from each broth culture were inoculated onto sheep blood agar, brain heart infusion agar (oxid), macConkey agar (oxid) and XLD agar (oxid) plates and incubated at 37 °C for 24 hours. Isolated colonies were picked up and identified morphologically, microscopically and biochemically according to Dufour-zavala *et al.* 2008.

Statistical Analysis: The Data obtained were statistically analyzed using t- test according to SPSS 14 (2006).

RESULTS

The results of the examination of the swab samples taken from different sites from both cage broiler and layer houses were recorded in tables 2&3. The results showed high initial contamination of cage houses specially in layer ones before cleaning and disinfection indicated by the high initial total colony counts of the collected swab samples. Also, there was highly significant reduction ($p < 0.001$) in the total colony count (T.C.C.) from different sites after cleaning and disinfection with both disinfectants with a depletion percentage reached 99.999%. The peroxygen products were more effective in reducing (T.C.C.) especially in the layer cage houses than the use of diluted formalin.

Table 2: The mean total colony counts of swab samples from Layer houses before cleaning and after cleaning and disinfection by different disinfectants.

samples		Disinfection method	Mean TCC (CFU/ml) before disinfection	Mean TCC(CFU/ml) after disinfection	Depletion %
Site	number				
walls	20	1	0.29x10 ¹⁰	0.02x10 ^{4*}	99,9999931
walls	20	2	0.41x10 ¹⁰	0.17x10 ^{2*}	99,9999959
batteries	20	1	3.7x10 ¹⁰	1.3x10 ^{4*}	99,99996486
batteries	20	2	2.6x10 ¹⁰	1.4x10 ^{2*}	99,9999946
floors	20	1	4.8x10 ¹⁰	5.2x10 ^{4*}	99,99989167
floors	20	2	3.2x10 ¹⁰	0.5x10 ^{2*}	99,99999984

*Significant at P< 0.001 using t-student test

Table 3: The mean total colony counts of swab samples from broiler houses before cleaning and after cleaning and disinfection by different disinfectants.

Samples		Disinfection method	Mean TCC	Mean TCC	Depletion %
site	number		(CFU/ml) before disinfection	(CFU/ml) after disinfection	
walls	20	1	0.14x10 ¹⁰	0.12x10 ^{2*}	99,99999914
walls	20	2	0.17x10 ¹⁰	0.08x10 ^{2*}	99,99999953
batteries	20	1	0.23x10 ¹⁰	1.6x10 ^{2*}	99,99999304
batteries	20	2	0.31x10 ¹⁰	1.1x10 ^{2*}	99,99999645
floors	20	1	3.2x10 ¹⁰	0.4x10 ^{2*}	99,99999988
floors	20	2	7.8x10 ¹⁰	0.2x10 ^{2*}	99,99999997

*Significant at P<0.001 using t-student test

On the other hand, the bacteriological examination of the swab samples (table 4) revealed the isolation of different types of pathogenic contaminant bacteria including *Bacillus spp.*, *Staphylococcus aureus*, *E.coli*, *Coliforms*, *Pseudomonas earuginosa*, and *Salmonella typhymurium* from both broiler and layer houses before cleaning and disinfection . It was found that The Peroxygen products (Degaclean 51 and Peraclean 15) were able to overcome most of the isolated pathogenic contaminant bacteria from both cage layer and broiler houses while formalin failed to do that except for *Salmonella typhymurium* contamination as both disinfectants were able to decontaminate it in both broiler and layer houses

Table 4: Results of the bacteriological examination of broiler and Layer houses before and after cleaning and disinfection by different disinfectants.

samples		Isolated microorganisms before disinfection	disinfection method	Isolated microorganisms after disinfection
houses	site			
Broiler	walls	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>Coliforms</i> , <i>E.coli</i> & <i>Pseudomonas earuginosa</i>
			2	<i>Bacillus spp.</i>
	Batteries	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> & <i>Salmonella typhymurium</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i> ,
			2	<i>Bacillus spp.</i>
	floors	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> & <i>Salmonella typhymurium</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i> ,
			2	<i>Bacillus spp.</i>
Layer	walls	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i> ,
			2	<i>Bacillus spp.</i>
	Batteries	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> & <i>Salmonella typhymurium</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i>
			2	<i>Bacillus spp.</i>
	floors	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> & <i>salmonella typhymurium</i>	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> & <i>Pseudomonas earuginosa</i> ,
			2	<i>Bacillus spp.</i>

The examination of water samples from different sources of the farms revealed the sterility of the main source (well hard water) while the water from the main storage tank and the houses storage tanks showed sever contamination with different contaminant bacteria which incriminated in inducing outbreaks among poultry including *Staphylococcus aureus*, *E.coli*, *coliforms*, *Pseudomonas earuginosa* and *Proteus spp.* (table 5). The water tanks were not enough protected against dropping of free living birds in addition to rodents and insects pollutions.

Table 5: Results of examination of water samples from different sources of water in both broiler and layer houses.

place of water sample	No. of samples	pH	Mean TCC (CFU/ML)	ISOLATED MICROORGANISMS
Well water	1	7.2	0	-
Main storage tank	1	7.1	1.1x10 ⁵	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> .
Houses storage tanks	8	7.1	4.8x10 ⁶	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> & <i>Proteus spp.</i>

On the other hand, on examination of the swab samples from the houses drinking water dispensers before and after cleaning and disinfection (tables 6 & 7) revealed that although both of the disinfectant used had the ability to significantly (p<0.001) reduced the TCC of the isolated bacterial populations (table 6) but the Peroxygen products (Degaclean 51 and Peraclean 15) were more effective in destroying the pathogenic contaminant bacteria (table 7).

Table 6: The mean total colony counts of swab samples from drinking water dispensers before and after cleaning and disinfection by different disinfectants.

Drinking water dispensers samples		disinfection method	Mean TCC (CFU/ml) before disinfection	Mean TCC(CFU/ml) after disinfection	Depleton %
Sample no.	No. of swabs				
Sample 1	40	1	0.14x10 ¹⁰	1. 2x10 ⁶ *	99,91428571
Sample 2	40	2	0.23x10 ¹⁰	0.6x10 ² *	99,99999739

*Significant at P< 0.001 using t-student test

Table 7: Results of the bacteriological examination of drinking water dispensers before cleaning and after cleaning and disinfection

Drinkers samples	Disinfection method	Isolated microorganisms before disinfection	Isolated microorganisms after disinfection
Sample 1	1	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i>	<i>Bacillus spp.</i> , <i>Staphylococcus aureus</i> , <i>E.coli</i> , <i>Coliforms</i> , <i>Pseudomonas earuginosa</i> .
Sample 2	2		<i>Bacillus spp.</i>

DISCUSSION

Cleaning and disinfection of poultry houses between production rounds is important to minimize infection and to eliminate pathogenic organisms. The current study was performed to evaluate 2 different categories of disinfectants commonly used in disinfection of poultry houses, formaldehyde and peroxygens under field circumstances. The programs in the study were based on those routinely used by the farmer to clean and disinfect the premises when the last flocks of broiler and laying hens were suffered from sanitary problem. The assessment of decontamination efficiency involves determining the number of viable microorganisms present on surfaces (Drouin and Toux, 1985).

In this investigation bacteriological monitoring highlighted the contamination of in battery cage houses with serious contaminant bacteria before cleaning and disinfection indicated by high total colony count of the collected swab samples of both broiler and layer houses. These high initial contamination results referred to the severe contamination of cage systems with the dropping belts, manure conveyors on the floor in addition to the cleaning difficulties especially in layer houses.

The obtained data after cleaning and disinfection indicating a lower standard of cleaning process was achieved in battery cage houses especially in layer cage houses before the disinfection application which reflected on the decontamination effect of disinfectants used especially formaldehyde to induce their action as cleaning is made difficult by the complexity of cage equipment and the inaccessibility of certain parts. These results agreed with Wales *et al.* (2006) who reported that Laying houses are notoriously difficult to clean thoroughly because of their intrinsically complicated structures, which are even more complex in the case of cage laying houses.

Also, the data collected showed that dilution errors might be occurred in formaldehyde treatment, which was performed by farm's workers. These results agreed with that obtained by many authors (Moustafa *et al.*, 2009; Huneau-Salau *et al.*, 2010) which underlines the necessity of improving farmers' and hygiene specialists' education on the use of disinfecting products in animal husbandry.

On the other hand, disinfectants may have a limited lifespan after their initial dilution and it is possible that heat, sunlight, humidity, time of application, organic matter, and adulterants may reduce their efficacy as the correct usage of disinfectants is an important component of a successful biosecurity program (Santos and Falconi, 2007 and Stringfellow *et al.*, 2009).

Both disinfectants were able to overcome *Salmonella typhimurium* contamination which detected in both broiler and layer houses which agreed with the results obtained by many authors (Carrique-Mas *et al.*, 2009; Stringfellow *et al.*, 2009; Dewaele *et al.*, 2011 and McLarene *et al.*, 2011).

Clean and fresh water free from pathogens is extremely important in poultry production and in the biosafety program of poultry farms to get best performance. There is another issue that can affect clean water supply which is the formation of "bio-film" in water pipes. A bio film is an aggregate of microorganisms surrounded and adhered to a surface by a slim substance in the water distribution system that may be difficult to clean between the batches. Bio film provides a haven to water borne pathogens.

In this investigation the water sample from the well source was sterile while that taken from water storage system and drinking water dispensers were heavily contaminated with different contaminated water born bacteria which constituted health hazard of poultry sanitation including *Staphylococcus aureus*, *E.coli*, *coliforms*, *Pseudomonas earuginosa* and *Proteus spp.* (tables 5&7). These results agreed with Cretikos *et al.* (2010) and Ferguson *et al.* (2011) who reported that there are supply system factors affecting the microbiological drinking water safety and drinking water systems without disinfection and appear to affects of water pollution, which presents a risk of waterborne disease outbreaks.

It was noticed that the water tanks were not enough protected against dropping of free living birds in addition to rodents and insects pollutions which constituted a serious threaten in the success of disinfection process and biosecurity program.

After cleaning and disinfection there was a huge decline in the bacterial load in drinkind water dispensers which indicated by lowered mean total bacterial count in both types of disinfectant used but peroxygen products were more efficient in destroying the pathogenic contaminant bacteria (tables 6,7). The peroxygen product used consisted of two components : (Degaclean 51) which used in removing of organic matter and biofilm before disinfection of poultry houses which greatly increased the disinfection efficiency of the second product (Peraclean 15) in destroying the contaminant bacteria. Furthermore, the application of the peroxgen products were performed under supervision of hygiene specialists that were more careful in applying the disinfectants according to the manufacturers' recommended working concentrations. multiple factors should be considered when a disinfectant is chosen, such as organic matter on the surface to be treated, presence of organic matter in the diluent, quality of water, corrosiveness or toxicity of the product, application method,

temperature, porosity of the surface being treated, length of contact time, infectious organisms targeted, susceptibility of the infectious organisms, and correct dilution (Prince *et al.*, 1991; Quinn and Markey, 2001; Dvorak, 2005; Payne *et al.*, 2005 and Stringfellow *et al.*, 2009).

On conclusion, a high standard planning of cleaning is of great importance prior to the application of the disinfection process and the correct usage of disinfectants in addition to effective program of eradication of rodent and insects are important components of a successful biosecurity program (Santos and Falconi, 2007; Stringfellow *et al.*, 2009). Also, which underlines the necessity of improving farmers' and hygiene specialists' education on the use of disinfecting products in poultry houses. It was recommended to use more environmental friendly safe and also efficient peroxegen disinfectants to alternate to the use of formaldehyde products which should be declined due to the strong, irritant odour, corrosiveness, fibrolytic properties and toxicity (Samberg and Meroz 1995). Also, the use of formaldehyde may soon become illegal in some countries due to environmental concerns.

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تقييم برامج للتطهير باستخدام مطهرات مختلفة في تطهير مساكن الدواجن تحت الظروف الحقلية

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تم من خلال هذه الدراسة تقييم كفاءة استخدام كل من ١٠% من محلول الفورمالين ومنتج تجارى من المركبات البيروكسي اسيتك في عنابر البطاريات لكل من التسمين والبياض تحت الظروف الحقلية. للقيام بهذا تم تجميع مسحات من أماكن مختلفة في أربع عنابر للتسمين والبياض تربي بنظام البطاريات بالإضافة إلى مسحات من ماكينات توزيع المياه داخل العنابر قبل وبعد عملية التنظيف والتطهير بالمطهرات المختلفة. كذلك تم اخذ عينات من مياه البئر الرئيسي ومياه الخزان الرئيسي وخزانات العنابر المختلفة قبل عملية التنظيف والتطهير. تم استخدام العد الميكروب الكلى للمسحات وعينات المياه بالإضافة إلى الفحص البكتيري للعينات المجمع للقيام بذلك التقييم. وقد أسفرت نتائج فحص عينات المياه انه على الرغم من خلو عينة المياه من البئر الرئيسي من التلوث الميكروبي فقد وجد تلوث شديد لعينات المياه المخزنة في كل من الخزان الرئيسي وخزانات العنابر مع احتوائها على مختلف أنواع البكتيريا المرضية التي شملت: المكورات العنقودية من فصيلة ستافيلوكوكاس أورياس ، الاى كولاى ، ميكروبات قولونية ، السودوموناس ابروجينوزا وعترات البروتيس. كذلك تم عزل نفس الأنواع من البكتيريا الممرضة من عينات المسحات بالإضافة إلى عزل ميكروبات السالمونيلا تيفيموريم من المسحات المأخوذة من الأرضيات والبطاريات لكل من عنابر التسمين والبياض. ومن ناحية اخرى فقد اثبتت نتائج الفحص الكفاءة الفعلية لكلا المطهرات المستخدمة فى تقليص العد الميكروبي الحيوى للمسحات المأخوذة من الأماكن المختلفة ومن ماكينات توزيع المياه فى العنابر بنسبة وصلت الى ٩٩,٩٩٩% ولكن استخدام الفورمالين بتركيز ١٠% فشل فى القضاء على بكتيريا التلوث الممرضة ما عدا ميكروبات السالمونيلا تيفيموريم التى تم التخلص منها عند استخدام كلا المطهرات المستخدمة. كذلك وجد أن كفاءة التعقيم كانت اكبر في عنابر التسمين عنها في عنابر البياض. وفي المجمل، تواجد خطة متكاملة للتنظيف قبل التطهير مع الاستخدام السليم للمطهر المناسب بالإضافة إلى وجود برنامج فعال للقضاء على الحشرات والقوارض له الأثر الفعال في نجاح عملية التطهير والأمان الحيوي لعنابر الدواجن. كذلك فان النتائج السابقة تلقى الضوء على أهمية تعليم المربين والمختصين بالتطهير إلى كيفية استخدام المطهرات المختلفة بأسلوب سليم. وأخيرا، فقد تم التوصية باستخدام مطهرات ذات كفاءة عالية مع كونها صديقة للبيئة لاستخدامها كبديل لمركبات الفورمالدهايد في عنابر الدواجن الذي سيكون استخدامه غير قانوني قريبا في بعض الدول نظرا لتأثيره الصحي الضار وخطره البيئي.