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Evaluation of Commercial Disinfectants Against Fungal Pathogens Isolated from Broiler Farms

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Abstract: Three different concentrations of five commercial disinfectants [TH4® 2, 1 and 0.5% (combination of quaternary ammonium compounds and gluteraldhyde), Microzal® 2, 1 and 0.5% (combination of quaternary ammonium compounds and gluteraldhyde), Incospect IC 22XA 2, 0.5 and 0.25% (combination of quaternary ammonium compounds, gluteraldhyde and formalin), Povidone Iodine® 5, 7.5 and 10% (iodophore) and Formalin® 3.7, 2.5 and 1.8% (commercial formaldehyde 37%)] were tested in a laboratory trials against two fungal isolates (*Aspergillus niger* and *Candida albicans*) at concentration of (~10^5) isolated during epidemiological surveillance in broilers farms. The trials were carried in the presence and absence of organic matter (dried yeast 5%) using MIC use-dilution test. Minutely samples were collected for the fungal counts. In the absence of organic matter, TH4® 2, 1 and 0.5% achieved 100% efficacy after 5, 5 and 10 min ($p \leq 0.001$) respectively against *Aspergillus niger* and *Candida albicans*. Microzal® 2, 1 and 0.5% achieved 100% efficacy after 5, 10 and 20 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5 min ($p \leq 0.001$) against *Candida albicans*. Incospect IC 22XA 2%, 0.5% and 0.25% achieved 100% efficacy after 5 min ($p \leq 0.001$) against *Aspergillus niger* and after 5, 5 and 10 min ($p \leq 0.001$) respectively against *Candida albicans*. Povidone Iodine® 10, 7.5 and 5% achieved 100% efficacy after 5, 5 and 20 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5, 5 and 20 min ($p \leq 0.001$) respectively against *Candida albicans*. Formalin® 3.7, 2.5 and 1.8% achieved 100% efficacy after 5, 10 and 10 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5, 5 and 10 min ($p \leq 0.001$) respectively against *Candida albicans*. In the presence of organic matter, TH4® 2, 1 and 0.5% achieved 100% efficacy after 5, 10 and 20 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5, 5 and 20 min ($p \leq 0.001$) respectively against *Candida albicans*. Microzal® 2, 1 and 0.5% achieved 100% efficacy after 5, 20 and 20 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5, 10 and 10 min ($p \leq 0.001$) respectively against *Candida albicans*. Incospect IC 22XA 2, 0.5 and 0.25% achieved 100% efficacy after 5 min ($p \leq 0.001$) against *Aspergillus niger* and after 5, 5 and 10 min ($p \leq 0.001$) respectively against *Candida albicans*. Povidone Iodine® 10, 7.5 and 5% achieved 100% efficacy after 30 min ($p \leq 0.001$) against *Aspergillus niger* and *Candida albicans*. Formalin® 3.7, 2.5 and 1.8% achieved 100% efficacy after 5, 10 and 20 min ($p \leq 0.001$) respectively against *Aspergillus niger* and after 5, 5 and 20 min ($p \leq 0.001$) respectively against *Candida albicans*. The results revealed that Incospect IC 22XA was the superior in the efficacy and the fastest disinfectant to achieve the 100% killing against the two organisms.

Key words: Disinfectants, evaluation, fungal pathogens, broiler

INTRODUCTION

The ventilating system of hatchery and hatching rooms was considered a source of heavily contamination with *Aspergillus fumigatus* which cause 10% mortality among newly hatched chicks. Decontamination of the ventilating system as well as hatching rooms generally reduced the losses from Aspergillosis, Muller-Lindloff (1984).

The majority (>99%) of airborne particles in broiler farms when examined were non-viable commensal bacterial from the skin. *Scopulariopsis* and *Aspergillus Sp* were the most prevalent fungi recovered from the air and bird's lungs respectively, the concentrations of airborne and lung fungi were positively correlated with ammonia concentrations, Wathes *et al*. (1991).

It was found that the number of micro-organisms in the barn ranged between 5.100:2.102 for *Coliform* group bacteria and 1.7.102:2.4.104 for mould mainly *Penicillium*, *Aspergillus*, *Alternaria*, *Cladosporium*, *mucor and Rhizopus* there were no significant differences of microbiological air contamination between buildings of old and modern types, Karwowska (2005).

The objective of disinfection is to reduce microbial population, Eckman (1994). Disinfectants act on microorganisms at several target sites resulting in

membrane disruption, metabolic inhibition and lysis of the cell, Denyer and Stewart (1998); Maillard (2002). Removal of old litter followed by cleaning and disinfection of facilities helps reduce pathogen numbers and break disease cycles or at the minimum, keep pathogen numbers from reaching a level that can cause disease outbreaks. In addition, as live production becomes the target area of programs for the reduction of human pathogens such as *Salmonellae* on poultry carcasses, it will become necessary to document that sanitation procedures are effective.

Several studies were carried out on disinfectants and many of these disinfectants are not considered to be environmentally safe e.g. gluteraldhyde, formaldehyde to show their effectiveness against *Salmonella*, Ramesh *et al*. (2002); Gradel *et al*. (2003-2004). Further, poultry houses have inaccessible equipment and considerable amounts of organic matter and high contents of protective compounds (fats, carbohydrates and proteins) from which *Salmonella* are difficult to remove, Gradel *et al*. (2004).

The aim of this study was to compare the effect of the five disinfectants at three different concentrations in relation to time against fungal isolates (*Aspergillus niger* and *Candida albicans*) in the presence and absence of organic matter as an extra-challenge to the action of the disinfectants.

MATERIALS AND METHODS

Preparation of the three tested concentrations of the chemical disinfectants: TH4® is a combination of four quaternary ammonium compounds and gluteraldhydes as well as plant extract (pine oil and turpine oil) were added to obtain a pleasant perfume. It contains gluteraldhyde as an acid solution and activated by sodium bicarbonate to alkaline pH. One liter contains gluteraldhyde (62.50 g), didecyle dimethyl ammonium chloride (18.75 g), dioctyl dimethyl ammonium chloride (18.75 g), octyl decyl dimethyl ammonium chloride (37.50 g), alkyl dimethyl benzyl ammonium chloride (50 g), Pine oil (20 g), Terpine oil (50 g). The concentrations to be tested were 2% (2 ml of TH4® solution was added to 100 ml distilled water, pH 8.9), 1% (1 ml of TH4® solution was added to 100 ml distilled water, pH 8.7) and 0.5% (0.5 ml of TH4® solution was added to 100 ml distilled water, pH 8.6).

Microzal® is synergistic blend of gluteraldhyde (hydrophilic biocide) and four exclusive Quaternary ammonium compounds (lipophilic biocide) with proven efficacy on all viruses responsible for major animal diseases, bacteria, fungi and Mycoplasma. The concentrations to be tested were 2% (2 ml of Microzal® solution was added to 100 ml distilled water, pH 7.9), 1% (1 ml of Microzal® solution was added to 100 ml distilled water, pH 8.4) and 0.5% (0.5 ml of Microzal® solution was added to 100 ml distilled water, pH 8.0).

Incospect IC 22XA is a combination of Bardac (22) didecyldimethyl ammonium chloride (100 g-20%), gluteraldhyde (80 g-16%) and formalin (32 g-9%). The concentrations to be tested were 2% (2 ml of Incospect IC 22XA was added to 100 ml distilled water, pH 9.2), 0.5% (0.5 ml of Incospect IC 22XA was added to 100 ml distilled water, pH 9.6) and 0.25% (0.25 ml of Incospect IC 22XA was added to 100 ml distilled water, pH 9.0).

Povidone iodine® is iodophore compound that have a characteristic odor. The concentrations to be tested were 5% (5 ml of Povidone iodine® was added to 100 ml distilled water, pH 7.2), 7.5% (7.5 ml of Povidone iodine® was added to 100 ml distilled water, pH 7.8) and 10% (10 ml of Povidone iodine® was added to 100 ml distilled water, pH 7.4).

Formaline® 37% is the most active chemical disinfectant against most types of micro-organisms as bacteria and their spores, fungi, viruses. The concentrations to be tested were 3.7% (3.7 ml of Formaline® 37% was added to 100 ml distilled water, pH 7.5), 2.5% (2.5 ml of Formaline® 37% was added to 100 ml distilled water, pH 7.9) and 1.8% (1.8 ml of Formaline® 37% was added to 100 ml distilled water, pH 7.8).

Propagation of the fungal isolates: The Fungal isolates (*Aspergillus niger* and *Candida albicans*) were propagated using pour plate method, Cruickshank *et al*. (1980). A loopful was transferred from all fungal colonies that was stored onto malt slants into 10 ml Sarbaroud Dextrose Broth and incubated at room temperature for 3 days. Tenfold serial dilutions were carried out into tubes containing 9 ml phosphate buffered saline, 1 ml from each dilution was transferred into a sterile petridish then about 10 ml of Sarbaroud Dextrose agar melted and cooled at 45°C were aseptically poured into each petridish. After thoroughly mixing the plates were left to solidify, incubated at room temperature for 5-7 days, The calculation was carried out using the following formula: Log (average CFU/drop vol.)(dilution factor) (Vol. scrapped into/surface area), Zelver *et al*. (1999) and Herigstad *et al*. (2001)

Preparation of the organic matter source: 5 % stock solution of yeast suspension (5 g of dried yeast was added to 100 ml of sterile distilled water); the yeast suspension was dispensed into 5 ml tubes, sterilized by autoclaving for 20 min at 121°C .

Evaluation of the efficacy of chemical disinfectants against the fungal pathogens: The laboratory evaluation of the efficacy of the chemical disinfectants was carried out using modified use- dilution test Robinson *et al*. (1988). The test was repeated twice; once in the presence of organic matter and the second time in the absence of the organic matter.

Evaluation of the efficacy of chemical disinfectants in the absence of organic matter: Fungal suspension was prepared and propagated. Ten ml of the tested chemical disinfectant were poured in a sterile test tube, 0.1 ml of the fungal suspension (~10^5) were added and shaken thoroughly to give the chance for micro-organisms to come in contact with the disinfectant. At time interval 5, 10, 20 and 30 min from original zero time 1 ml of disinfectant-fungal mixture were taken into tube containing 9 ml of in-activator (Tween 80 3%) in nutrient broth, mix thoroughly. One ml from in-activator tubes was used for the fungal count using pour plate method, Cruickshank *et al*. (1980). The numbers of survival organisms on each plate were counted. The calculation was carried out using the following formula: Log (average CFU/drop vol.) (dilution factor) (Vol. scrapped into/ surface area), Zelver *et al*. (1999) and Herigstad *et al*. (2001).

Evaluation of the efficacy of chemical disinfectants in the presence of organic matter: A suspension of fungal yeast extract mixture was prepared by adding 4.5 ml Yeast extract 5% to 0.5 ml of the fungal suspension (~10^5) and mixed gently. Nine ml of tested chemical disinfectant concentration were poured in a sterile test tubes, 1 ml of fungal yeast extract mixture was added and shaken thoroughly to give the chance for micro-organisms to come in contact with the disinfectant. At time interval 5, 10, 20 and 30 min. from original zero time 1 ml of disinfectant fungal yeast extract mixture from each tube were taken to the corresponding tube containing 9ml of in-activator (Tween 80 3%) in nutrient broth, mix thoroughly. One ml from in-activator tubes was used for the fungal count using pour plate method, Cruickshank *et al*. (1980). The numbers of survival organism on each plate were counted. The calculation was carried out using the following formula: Log (average CFU/drop vol.) (dilution factor) (Vol. scrapped into/ surface area), Zelver *et al*. (1999) and Herigstad *et al*. (2001).

Statistical analysis: The statistical analysis was carried out by performing analysis of variance (ANOVA, GLM, MIXED) using SAS 9.2.0 software.

RESULTS AND DISCUSSION

The objective of this study was to evaluate the efficacy of some commercial disinfectants that was not proven to be environmentally safe and if it is possible to be used in poultry houses while the birds are still present.

In the absence of organic matter, TH4® 2%, Microzal® 2%, Incospect IC 22XA 2%, Povidone Iodine® 10% and Formalin® 3.7% achieved 100% efficacy against *Aspergillus niger* after 5 min ($p \leq 0.0001$) (Table 1).

In the presence of organic matter, TH4® 2%, Microzal® 2%, Incospect IC 22XA 2% and Formalin® 3.7% achieved the 100% efficacy after 5 min ($p \leq 0.0001$). Povidone Iodine® 10% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.98%) and showed the 100% efficacy after 30 min ($p \leq 0.0001$), Table 1.

In the absence of organic matter, TH4® 1%, Incospect IC 22XA 0.5%, Povidone Iodine® 7.5% achieved 100% efficacy against *Aspergillus niger* after 5 min ($p \leq 0.0001$). Microzal® 1% and Formalin® 2.5% starting to show high efficacy after 5 min ($p \leq 0.0001$) with killing efficacy (99.99%) and (99.97%) respectively and showed 100% efficacy after 10 min ($p \leq 0.0001$) (Table 2).

In the presence of organic matter, Incospect IC 22XA 0.5% achieved the 100% efficacy after 5 min ($p \leq 0.0001$). TH4® 1% and Formalin® 2.5% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.98%) and (99.97%) respectively and showed the 100% efficacy after 10 min ($p \leq 0.0001$). Microzal® 1% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.94%) and showed 100% efficacy after 20 min ($p \leq 0.0001$). Povidone Iodine® 7.5% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.97%) and showed the 100% efficacy after 30 min ($p \leq 0.0001$) (Table 2).

In the absence of organic matter, Incospect IC 22XA 0.25% achieved 100% efficacy against *Aspergillus niger* after 5 min ($p \leq 0.0001$). TH4® 0.5% and Formalin® 1.8% starting to show high efficacy after 5 min ($p \leq 0.0001$) with killing efficacy (99.96%) and (99.99%) respectively and showed 100% efficacy after 10 min ($p \leq 0.0001$). Microzal® 0.5% and Povidone Iodine® 5% starting to show high efficacy after 5 min ($p \leq 0.0001$) with killing efficacy (99.96%) and (99.99%) respectively and showed 100% efficacy after 20 min ($p \leq 0.0001$) (Table 3).

In the presence of organic matter, Incospect IC 22XA 0.5% starting to show high efficacy against *Aspergillus niger* after 5 min ($p \leq 0.0001$) with killing efficacy (99.99%) and achieved the 100% efficacy after 10 min ($p \leq 0.0001$). TH4® 0.5%, Microzal® 0.5% and Formalin® 1.8% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.95%), (99.96%) and (99.96%) respectively and showed the 100% efficacy after 20 min ($p \leq 0.0001$). Povidone Iodine® 5% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.97%) and showed the 100% efficacy after 30 min ($p \leq 0.0001$) (Table 3).

In the absence of organic matter, TH4® 2%, Microzal® 2%, Incospect IC 22XA 2%, Povidone Iodine® 10% and Formalin® 3.7% achieved 100% efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$) (Table 4).

In the presence of organic matter, TH4® 2%, Microzal® 2%, Incospect IC 22XA 2% and Formalin® 3.7% achieved the 100% efficacy after 5 min ($p \leq 0.0001$). Povidone Iodine® 10% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.98%) and showed 100% efficacy after 30 min ($p \leq 0.0001$) (Table 4).

Table 1: Efficacy of the 1st concentration of each chemical disinfectant against *Aspergillus niger* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Microzal®	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Incospect IC 22XA	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Povidone Iodine®	10	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.69^{a*}	3.61^{b*}	3.49^{b}	0^{c**}
		Killing %	100	100	100	100	99.98	99.98	99.99	100
Formalin®	3.7	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100

^{a,b,c}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

Table 2: Efficacy of the 2nd tested concentration of each chemical disinfectant against *Aspergillus niger* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	1	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.51^{a**}	0^{b**}	0^{b}	0^{b}
		Killing %	100	100	100	100	99.98	100	100	100
Microzal®	1	Log_{10} count	3.49^{a**}	0^{b**}	0^{b}	0^{b}	4.13^{a**}	3.94^{b**}	0^{c**}	0^{c}
		Killing %	99.99	100	100	100	99.94	99.96	100	100
Incospect IC 22XA	0.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Povidone Iodine®	7.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.83^{a*}	3.50^{b*}	3.49^{b}	0^{c**}
		Killing %	100	100	100	100	99.97	99.98	99.99	100
Formalin®	2.5	Log_{10} count	3.84^{a**}	0^{b**}	0^{b}	0^{b}	3.74^{a**}	0^{b**}	0^{b}	0^{b}
		Killing %	99.97	100	100	100	99.97	100	100	100

^{a,b,c}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

Table 3: Efficacy of the 3rd tested concentration of each chemical disinfectant against *Aspergillus niger* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	0.5	Log_{10} count	3.90^{a**}	0^{b**}	0^{b}	0^{b}	4.11^{a**}	3.91^{b**}	0^{c**}	0^{c}
		Killing %	99.96	100	100	100	99.95	99.96	100	100
Microzal®	0.5	Log_{10} count	3.94^{a**}	3.81^{b**}	0^{c**}	0^{c}	3.90^{a**}	3.50^{b**}	0^{c**}	0^{c}
		Killing %	99.96	99.96	100	100	99.96	99.98	100	100
Incospect IC 22XA	0.25	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.47^{a**}	0^{b**}	0^{b}	0^{b}
		Killing %	100	100	100	100	99.99	100	100	100
Povidone Iodine®	5	Log_{10} count	3.94^{a**}	3.50^{b*}	0^{c**}	0^{c}	3.83^{a*}	3.50^{b*}	3.49^{b}	0^{c**}
		Killing %	99.96	99.99	100	100	99.97	99.98	99.99	100
Formalin®	1.8	Log_{10} count	3.47^{a**}	0^{b**}	0^{b}	0^{b}	4.06^{a**}	3.81^{b**}	0^{b}	0^{b}
		Killing %	99.99	100	100	100	99.95	99.97	100	100

^{a,b,c}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

In the absence of organic matter, TH4® 1%, Microzal® 1%, Incospect IC 22XA 0.5%, Povidone Iodine® 7.5% and Formalin® 2.5% achieved 100% efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$) (Table 5).

In the presence of organic matter, TH4® 1%, Incospect IC 22XA 0.5% and Formalin® 2.5% achieved the 100% efficacy after 5 min ($p \leq 0.0001$). Microzal® 1% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.99%) and showed 100% efficacy after 10 min ($p \leq 0.0001$). Povidone Iodine® 7.5% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.96%) and showed the 100% efficacy after 30 min ($p \leq 0.0001$) (Table 5).

In the absence of organic matter, Microzal® 0.5% achieved 100% efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$). TH4® 0.5%, Incospect IC 22XA 0.25% and Formalin® 1.8% starting to show high efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$) with

Table 4: Efficacy of the 1st tested concentration of each chemical disinfectant against *Candida albicans* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Microzal®	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Incospect IC 22XA	2	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Povidone Iodine®	10	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.69^{a*}	3.63^{b*}	3.49^{b}	0^{c**}
		Killing %	100	100	100	100	99.98	99.98	99.99	100
Formalin®	3.7	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100

^{a,b,c}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

Table 5: Efficacy of the 2nd tested concentration of each chemical disinfectant against *Candida albicans* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	1	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Microzal®	1	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.47^{a**}	0^{b**}	0^{b}	0^{b}
		Killing %	100	100	100	100	99.99	100	100	100
Incospect IC 22XA	0.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100
Povidone Iodine®	7.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.94^{a*}	3.69^{b*}	3.47^{c*}	0^{d**}
		Killing %	100	100	100	100	99.96	99.98	99.99	100
Formalin®	2.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	0^{a**}	0^{a}	0^{a}	0^{a}
		Killing %	100	100	100	100	100	100	100	100

^{a,b,c,d}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

Table 6: Efficacy of the 3rd tested concentration of each chemical disinfectant against *Candida albicans* in the absence and presence of organic matter

			Absence of organic matter				Presence of organic matter			
			Time/min				Time/min			
Disinfectants	Conc. (%)	Parameter	5	10	20	30	5	10	20	30
TH4®	0.5	Log_{10} count	3.47^{a**}	0^{b**}	0^{b}	0^{b}	3.94^{a**}	3.69^{b*}	0^{c**}	0^{c}
		Killing %	99.99	100	100	100	99.96	99.98	100	100
Microzal®	0.5	Log_{10} count	0^{a**}	0^{a}	0^{a}	0^{a}	3.49^{a**}	0^{b**}	0^{b}	0^{b}
		Killing %	100	100	100	100	99.99	100	100	100
Incospect IC 22XA	0.25	Log_{10} count	3.89^{a**}	0^{b**}	0^{b}	0^{b}	3.47^{a*}	0^{b**}	0^{b}	0^{b}
		Killing %	99.96	100	100	100	99.99	100	100	100
Povidone Iodine®	5	Log_{10} count	3.84^{a**}	3.47^{b*}	0^{c**}	0^{c}	3.94^{a*}	3.69^{b*}	3.47^{c*}	0^{d**}
		Killing %	99.97	99.99	100	100	99.96	99.98	99.99	100
Formalin®	1.8	Log_{10} count	3.47^{a**}	0^{b**}	0^{b}	0^{b}	3.79^{a*}	3.50^{b*}	0^{c**}	0^{c}
		Killing %	99.99	100	100	100	99.97	99.98	100	100

^{a,b,c,d}Represented the significance between the different sampling time within each disinfectant.
*Represents values with significance at $p \leq 0.001$, **Represents values with highly significance at $p \leq 0.0001$

killing efficacy (99.99%), (99.96%) and (99.99%) respectively and achieved the 100% efficacy after 10 min ($p \leq 0.0001$). Povidone Iodine® 5% starting to show high efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$) with killing efficacy (99.97%) and achieved the 100% efficacy after 20 min ($p \leq 0.0001$) (Table 6).

In the presence of organic matter, Microzal® 0.5% and Incospect IC 22XA 0.25% starting to show high efficacy against *Candida albicans* after 5 min ($p \leq 0.0001$) with killing efficacy (99.99%) and achieved 100% efficacy after 10 min ($p \leq 0.0001$). TH4® 0.5% and Formalin® 1.8% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.96%) and (99.97%) respectively and showed the 100% efficacy after 20 min ($p \leq 0.0001$). Povidone Iodine® 5% starting to show high efficacy after 5 min ($p \leq 0.001$) with killing efficacy (99.96%) and showed the 100% efficacy after 30 min ($p \leq 0.0001$) (Table 6).

Summary: In general; the results revealed that quaternary ammonium compounds and gluteraldhyde (TH4®, Microzal® and Incospect IC 22XA) are the most powerful disinfectants against the fungal and mycotic organism in the presence and absence of organic matter and this may be attributed to the synergistic action they have in between that encourage the usage of these compounds. Further studies are required to investigate the efficacy of these compounds on pathogens in the poultry houses as the laboratory investigation did not reflect the reality of the actual environment in the houses.

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