環控鴨舍空氣污染物之基本資料建立[1]

蘇晉暉[2] 林榮新[2][6] 蕭庭訓[3] 黃振芳[2] 李舜榮[5] 郭猛德[4]

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摘要

本試驗目的在建立環控鴨舍空氣污染物之基本資料。蛋鴨飼養於水簾式環控鴨舍內，並依環控程式啟動風扇及水簾。試驗每季測定氨氣、甲基胺、二氧化碳、鴨舍內風速、溫度以及溼度。測定點分六處：近水簾鴨籠、近風扇鴨籠（分別測定上層與下層）、出風口、橫向刮糞溝、近水簾縱向刮糞溝及近風扇縱向刮糞溝，分別在清洗後第 0、24、48 以及 72 小時測量一次。總結來說，氨氣及甲基胺的濃度有隨著清洗後時間的增加而上升之趨勢，且在靠近風扇端之刮糞溝，其濃度上升最明顯。鴨舍內 CO_2 濃度介於 332 至 565 ppm 。風速、溫度與濕度受不同季節的氣候影響。由本試驗結果得知，環控鴨舍內氨氣及甲基胺的濃度可藉由強制通風維持於低濃度。

關鍵詞：空氣污染物、鴨舍、異味。

緒言

畜牧業臭味的問題引起越來越多的抱怨（Hobbs *et al*., 1995），為了提升畜禽生產效率及改善飼養環境，並減少畜禽生產受環境氣候變化之衝擊，國內畜禽生產業者使用環控式畜舍的業者越來越多。環控式畜舍雖可提供畜禽適宜的生產環境、維持穩定之生產效益，但也因密閉環境易造成畜舍內空氣品質不佳。此外，若畜舍內糞尿的清除、管理或通風系統之控制不當時，易使畜舍內產生對動物有害之氣體，將對管理者與畜禽的健康造成影響。

高濃度的氨氣會降低家禽的生長速度（Quarles and Kling, 1974；Reece *et al*., 1979）、飼料效率（Caveny and Quarles, 1978；Caveny *et al*., 1981）、產蛋（Deaton *et al*., 1984）並傷害呼吸道 (Anderson *et al*., 1964；Nagaraja *et al*., 1983)。Carlile（1984）建議禽舍內的氨氣濃度不可超過 25 ppm。畜牧場之空氣污染物主要來自畜禽糞尿、腐敗之飼料及動物身體等，其中糞便為主要來源（Chavez *et al*., 2004），

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(1) 行政院農業委員會畜產試驗所研究報告第 1756 號。
(2) 行政院農業委員會畜產試驗所宜蘭分所。
(3) 行政院農業委員會畜產試驗所經營組。
(4) 已退休，行政院農業委員會畜產試驗所經營組。
(5) 已退休，行政院農業委員會畜產試驗所宜蘭分所。
(6) 通訊作者，E-mail: ljh@mail.thri.gov.tw。

而其臭味之成分主要包含氨氣、硫化氫、硫醇、三甲基胺、硫化甲基以及糞臭素等（陳，2007；Leneman *et al.*, 1998；Ni *et al.*, 1999；Demmers *et al.*, 2003）。研究證實於飼料中添加氯化鈣，可減少豬舍糞便散發氨氣達 33%（Canh *et al.*, 1998）。謝（1998）指出氨氣是一種無色、刺激性的氣體，當人可感覺其臭味時濃度約已高達 25 ppm ，禽舍應維持低於 20 ppm 為佳；氨氣的來源為含氮物質分解成尿酸後再經過一連串之分解而成氨氣。

目前國內對於環控畜禽舍內空氣污染物之濃度評估，除養雞場與堆肥場外較為缺乏，尤以水禽場更甚。爲因應未來水禽飼養場可能陸續建成的環控畜舍，建立環控鴨舍空氣污染物之基本資料，並提供操作簡易、有效之空氣污染防治設備，可促進我國水禽飼養產業技術，促進產業升級，使畜牧生產兼顧環境保護，以達到產業永續經營之目標。

材料與方法

I. 試驗設計

約 900 隻宜蘭分所自行育成的產蛋菜鴨飼養於環控鴨舍內，採乳頭式給水。鴨隻飼料與飲水任飼，飼料營養依「鴨隻營養分需要量手冊」（沈，1988）建議值給予，含代謝能 2,730 kcal/kg、粗蛋白質 18.7%。鴨舍長度 60 公尺，寬度 12 公尺（如圖 1），鴨舍內設置 6 大排鐵製鴨籠（35 公分長 x 30 公分寬 x 40 公分高），每大排鴨籠又分為上、下排。鴨籠下方設置 85 公分寬 x 17 公分深之縱向刮糞溝，上、下排鴨籠之底板分別距縱向刮糞溝 40 公分及 90 公分。離風扇 52 公分處設有一橫向刮糞溝（1116 公分長 x 98 公分寬 x 49 公分高）。並依環控程式啟動風扇及水簾。分別於 4 季（2、5、8 及 11 月份）內進行試驗，每測定項目重複測定 3 次。測定項目包含氨氣、甲基胺、CO_2 濃度、風速、溫度以及溼度。測定點有六處，分別在近水簾端（20 公尺）及近風扇端（20 公尺）處之上、下層鴨籠（分別離地面 50 及 100 公分)、出風口（離風扇 1 公尺，距地面 130 公分）、橫向刮糞溝 (離風扇 2 公尺，距地面 30 公分）、近水簾縱向刮糞溝（離水簾 2.5 公尺，距地面 50 公分）以及近風扇縱向刮糞溝（離風扇 2.5 公尺，距地面 50 公分)。測量時間點為鴨舍清洗後第 0、24、48 及 72 小時各測定一次。

氨氣及甲基胺臭味之量測使用商業生產之空氣檢知管（GASTEC, GV–100, Japan），此檢知管為半定量性篩檢用，藉導入之空氣成分與管中化學物質之呈色反應得知刻度數值，可立即知悉特定臭味之濃度。此法常用於含還原態硫及氮化物之檢出（陳，2007）。

II.統計分析

試驗所得資料依統計模式利用統計分析系統（statistical analysis system；SAS, 1988）進行統計分析，使用一般線性模式程序（general linear model procedure, GLM）進行變方分析，再以特奇公正顯著差異法（Tukey’s honest significant difference）比較處理間差異之顯著性（Steel and Torrie, 1980）。

結果與討論

在氨氣濃度方面，於鴨舍清洗後立即測定的濃度，除近風扇縱向刮糞溝在 0.90﹣1.83 ppm 範圍內，其餘五個測定點之濃度皆在 1.03 ppm 以下（表 1）。大體而言，氨氣的濃度自鴨舍清洗後第 0、24、48、72 小時隨時間增加其氨氣濃度走高之趨勢（表 1）。黃（1985）指出，氨氣濃度升高使管理人員作嘔眩暈，且刺激眼睛。當氨氣含量在 10–15 ppm 時管理人員就可以嗅到氨氣的特殊氣味；20﹣25

ppm 時對眼睛有刺激，開始會流鼻涕；50 ppm 時眼瞼發炎；75 ppm 則開始有中毒的現象。Sainsbury（1980）認為禽舍氨氣濃度能被接受的上限為 20 ppm；Bruce（1981）亦認為氨氣濃度應限制於 20 ppm 以下。黃（1985）指出，雞隻通常在 20 ppm 以下，即遭受損害，所以必須進行換氣。Donham（1987）研究建議：對工作人員氨氣濃度應維持在 7–9 ppm 以下，對動物則應維持於 25 ppm 以下；而本試驗在鴨舍清洗後第 72 小時測定氨氣之濃度最高值為 7.17 ppm ，尚在文獻值（20 ppm）忍受範圍內。另有文獻指出，畜舍經過清洗後，可作到幾無臭味的程度，豬舍清洗後可使空氣中的 H_2S 幾乎完全去除，而氨氣可去除 50%以上（蕭，2005）。由本試驗的結果得知，鴨舍建議至少每 3 天清洗一次，以避免鴨舍內氨氣的濃度過高影響工作人員健康。

甲基胺、二甲基胺與三甲基胺是動物腸道內細菌代謝肌酸、卵磷脂與膽鹼的產物，並會在糞與尿中揮發（Asatoor and Simenhoff, 1965）。在鴨舍清洗後立即測定甲基胺之濃度，以近水簾鴨籠及出風口二處的甲基胺濃度較低，其甲基胺濃度在 0.27–0.57 ppm 之間；而近風扇縱向刮糞溝甲基胺濃度則在 0.83–1.53 ppm 的範圍，有較其他五個測定點高的趨勢。甲基胺的濃度自鴨舍清洗後第 0、24、48、72 小時隨時間增加其濃度越高（表 2）。各月份測定之甲基胺最高濃度皆位在近風扇縱向刮糞溝，且以 11 月份於清洗後 72 小時達 9 ppm 最高。

過去對於二氧化碳的研究並不如氨氣這麼多，因為 CO_2 的排放通常不認為是環境的污染物（IPCC, 2006），而是動物代謝的產物，且會隨著動物的生長與呼吸而增加（Miles *et al*., 2006)。研究指出，7 週齡大的白肉雞在夏季與冬季每小時分別製造 5.77 與 6.29 公克的 CO_2（Calvet *et al*., 2011）。豬場環境內 CO_2 濃度介於 600–894 ppm 之間（蕭，2005）；在羊舍內 CO_2 濃度平均為 500–650 ppm 之間（張，2002）。本試驗各月份試驗結果的比較，環控鴨舍內之各測定點 CO_2 濃度並無顯著差異；針對清洗後不同時間的比較，環控鴨舍內各測定點其 CO_2 濃度亦無顯著差異。2 月份 CO_2 濃度介於 332–488 ppm 之間，5 月份 CO_2 濃度介於 419–565 ppm 之間，8 月份 CO_2 濃度介於 379–476 ppm 之間，11 月份 CO_2 濃度則介於 393–468 ppm 之間（表 3）；由此可知，環控鴨舍內 CO_2 濃度略低於一般畜舍。

在風速方面，各季節中不同測定點皆以出風口的風速最快，在 3.23–7.60 m/s 之間，顯著較其餘五個測定點高（$P<0.05$），這可能是因為出風口的測定點距離風扇僅約 1 公尺。在清洗後第 0、24、48、72 小時方面，環控鴨舍內各測定點其風速皆無顯著差異（表 4）。

溫度方面，環控鴨舍內之溫度以 2 月份最低，其溫度在 14.9–18.1℃之間；由於臺灣 2 月份外界環境溫度較低，故環控鴨舍內之溫度亦會受到影響。環控鴨舍內的溫度以 8 月份較高，其溫度在 24.4–26.7℃之間，由於此時外界溫度環境較高，水簾環控鴨舍雖然能降低鴨舍內的溫度，但其效果仍有限。不同測量時間對於 2 月份及 11 月份環控鴨舍內的溫度無顯著差異（表 5）。在溼度方面，2 月份的環控鴨舍內的濕度相對較低，在 78.8%–95.1%之間；溼度以 11 月份最高，全部都在 90%以上（91%–100%），可能是因為此時宜蘭地區陰雨綿綿的氣候所導致。依據中央氣象局歷史統計資料顯示，宜蘭地區 2007 年各月份平均相對溼度分別為 2 月份 74%、5 月份 80%、8 月份 81%、11 月份 83%；降水日數（≧ 0.1 mm）分別為 2 月份 12 天、5 月份 14 天、8 月份 18 天、11 月份 26 天。郭（2008）指出豬舍外之平均溼度為 62.2 ± 5.1%，水簾式豬舍前方靠近水簾處濕度為 88.8 ± 3.9%，中央為 91.8 ± 4.3%，後方靠近風扇處為 87.3 ± 4.5%，顯示水簾式豬舍之濕度顯著比外界濕度高。由於水簾式畜禽舍內部有較高溼度的現象，在給予動物飼糧時，需更審慎斟酌給予的飼料量，減少飼糧發霉損壞的可能，避免動物健康遭受危害。

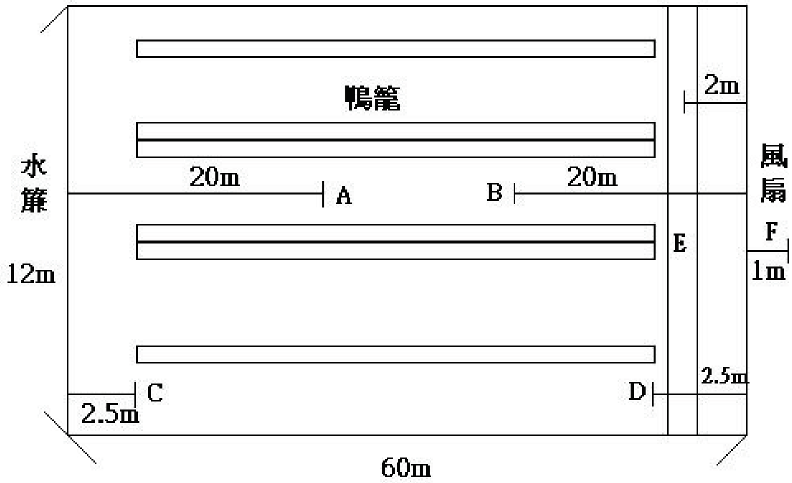

圖 1. 環控鴨舍及取樣點示意圖：
A：近水簾鴨籠；B：近風扇鴨籠；C：:近水簾縱向刮糞溝；D：:近風扇縱向刮糞溝；E：橫向刮糞溝；F：出風口。

Fig. 1. The sketch of environment-controlled duck house and the sampling sites:
A: cage near water pad, B: cage near fan, C: longitudinal feces collector near water pad, D: longitudinal feces collector near fan, E: transverse feces collector, F: air outlet.

結論與建議

試驗結果顯示，環控鴨舍可顯著降低鴨舍內部的溫度，但也會同時提高內部的溼度，是管理上需要注意的地方。在可能影響動物的氣體污染物部分，環控鴨舍強制通風的特性，使畜舍內氨氣及甲基胺的濃度於鴨舍沖洗後 72 小時尚可維持於低的濃度。由於實際清洗頻率多低於 72 小時，因此環控鴨舍在正常運作的情況下，其室內有害氣體的濃度並不足以使動物的生產性能受到影響。

表 1. 環控鴨舍內不同位置於各不同月份與清洗時間後氨氣濃度之變化

Table 1. The change of ammonia concentration in different site of the environment-controlled duck house in different month and time after washing

Sampling site	Time after washing 0 hr	24 hr	48 hr	72 hr
	-------------------------------Ammonia (ppm)			---------------------------------
		February		
Cage near water pad	0.35^{b,x} ± 0.09	0.73^{b,wx} ± 0.23	1.00^{ab,wx} ± 0.25	1.22^{b,w} ± 0.45
Cage near fan	0.90^{ab,x} ± 0.41	1.25^{b,wx} ± 0.25	1.65^{ab,wx} ± 0.30	2.17^{b,w} ± 0.76
Air outlet	0.10^{b,x} ± 0.00	0.53^{b,wx} ± 0.45	0.70^{b,wx} ± 0.52	1.00^{b,w} ± 0.00
Transverse feces collector	0.70^{ab,x} ± 0.52	3.17^{ab,w} ± 1.04	3.83^{ab,w} ± 1.04	4.17^{ab,w} ± 0.76
Longitudinal feces collector near water pad	0.23^{b,x} ± 0.23	1.50^{ab,wx} ± 0.50	1.33^{ab,wx} ± 0.29	3.33^{ab,w} ± 1.76
Longitudinal feces collector near fan	1.83^{a} ± 1.04	4.13^{a} ± 2.07	6.00^{a} ± 4.36	7.17^{a} ± 5.35
		May		
Cage near water pad	0.23^{b} ± 0.23	0.42^{b} ± 0.32	0.37^{b} ± 0.31	0.70^{b} ± 0.20
Cage near fan	0.60^{ab,x} ± 0.36	0.92^{b,wx} ± 0.14	1.17^{b,wx} ± 0.14	1.38^{b,w} ± 0.38
Air outlet	0.23^{b,x} ± 0.23	1.23^{b,w} ± 0.25	1.00^{b,w} ± 0.00	1.40^{b,w} ± 0.17
Transverse feces collector	0.83^{ab,x} ± 0.29	5.00^{a,w} ± 2.65	5.50^{a,w} ± 1.50	5.00^{a,w} ± 0.87
Longitudinal feces collector near water pad	0.10^{b,x} ± 0.00	0.25^{b,x} ± 0.21	0.90^{b,wx} ± 0.14	1.50^{b,w} ± 0.71
Longitudinal feces collector near fan	1.50^{a,y} ± 0.71	3.00^{ab,x} ± 0.00	5.00^{a,w} ± 0.00	5.50^{a,w} ± 0.71
		August		
Cage near water pad	0.42 ± 0.28	0.65^{c} ± 0.18	0.68^{c} ± 0.43	0.68^{c} ± 0.10
Cage near fan	0.45^{x} ± 0.26	0.85^{c,wx} ± 0.18	1.35^{c,w} ± 0.61	0.85^{bc,wx} ± 0.25
Air outlet	0.23^{x} ± 0.23	0.83^{c,w} ± 0.29	1.00^{c,w} ± 0.00	1.00^{c,w} ± 0.00
Transverse feces collector	1.03^{x} ± 0.81	3.33^{ab,w} ± 0.29	4.50^{ab,w} ± 1.00	5.17^{ab,w} ± 0.76
Longitudinal feces collector near water pad	0.67 ± 0.49	1.90^{bc} ± 1.49	2.17^{bc} ± 1.44	2.67^{bc} ± 2.93
Longitudinal feces collector near fan	1.17^{x} ± 0.58	4.60^{a,w} ± 0.53	5.33^{a,w} ± 1.44	7.00^{a,w} ± 0.87
		November		
Cage near water pad	0.43^{ab,x} ± 0.31	0.85^{b,wx} ± 0.26	1.32^{b,w} ± 0.14	1.42^{b,w} ± 0.29
Cage near fan	0.65^{ab,x} ± 0.35	1.32^{b,x} ± 0.55	1.73^{b,wx} ± 0.33	2.63^{b,w} ± 0.55
Air outlet	0.23^{ab,x} ± 0.23	0.53^{b,wx} ± 0.45	1.00^{b,w} ± 0.00	1.17^{b,w} ± 0.29
Transverse feces collector	0.77^{ab,x} ± 0.25	3.50^{ab,w} ± 0.00	3.67^{ab,w} ± 2.08	4.00^{ab,w} ± 2.00
Longitudinal feces collector near water pad	0.20^{b,x} ± 0.10	2.67^{ab,wx} ± 0.58	3.00^{ab,wx} ± 2.65	4.83^{ab,w} ± 2.75
Longitudinal feces collector near fan	0.90^{a,x} ± 0.17	6.33^{a,w} ± 3.21	7.00^{a,w} ± 1.63	7.17^{a,w} ± 1.04

Means ± S.D.

$^{a, b, c}$ Means in the same month within the same column without the same superscript are significantly different (P＜0.05).

$^{w, x, y}$ Means for the same sampling site within the same row without the same superscript are significantly different (P＜0.05).

表 2. 環控鴨舍內各季節與清洗後甲基胺濃度之變化

Table 2. The change of methylamine concentration in environment-controlled duck house in different season and time after washing

	Time after washing			
Sampling site	0 hr	24 hr	48 hr	72 hr
	--------Methylamine (ppm)--------			
	February			
Cage near water pad	$0.57^{x} \pm 0.12$	$0.80^{c,wx} \pm 0.05$	$1.22^{b,wx} \pm 0.06$	$1.28^{c,w} \pm 0.49$
Cage near fan	$0.80^{x} \pm 0.43$	$1.58^{bc,wx} \pm 0.29$	$1.85^{ab,wx} \pm 0.40$	$2.47^{bc,w} \pm 0.63$
Air outlet	$0.47^{x} \pm 0.06$	$1.00^{c,wx} \pm 0.50$	$0.90^{b,wx} \pm 0.26$	$1.17^{c,w} \pm 0.29$
Transverse feces collector	$1.03^{x} \pm 0.45$	$4.30^{ab,wx} \pm 2.56$	$5.50^{ab,w} \pm 2.29$	$5.50^{ab,w} \pm 1.32$
Longitudinal feces collector near water pad	$1.23^{x} \pm 0.68$	$2.23^{abc,wx} \pm 0.25$	$1.67^{ab,wx} \pm 0.29$	$3.50^{bc,w} \pm 1.32$
Longitudinal feces collector near fan	$1.53^{x} \pm 1.76$	$4.60^{a,wx} \pm 2.62$	$6.17^{a,wx} \pm 3.55$	$7.67^{a,w} \pm 2.52$
	May			
Cage near water pad	$0.35^{d} \pm 0.13$	$0.55^{b} \pm 0.20$	$0.52^{b} \pm 0.08$	$0.60^{b} \pm 0.10$
Cage near fan	$0.73^{bc,x} \pm 0.08$	$0.93^{b,wx} \pm 0.18$	$1.18^{b,wx} \pm 0.21$	$1.28^{b,w} \pm 0.40$
Air outlet	$0.50^{cd,x} \pm 0.00$	$1.17^{b,w} \pm 0.29$	$1.27^{b,w} \pm 0.25$	$1.33^{b,w} \pm 0.29$
Transverse feces collector	$0.87^{b,x} \pm 0.12$	$5.90^{a,w} \pm 2.15$	$6.17^{a,w} \pm 1.53$	$7.83^{a,w} \pm 0.29$
Longitudinal feces collector near water pad	$0.60^{c,x} \pm 0.14$	$0.75^{b,x} \pm 0.64$	$1.25^{b,wx} \pm 0.35$	$1.35^{b,w} \pm 0.92$
Longitudinal feces collector near fan	$1.15^{a,x} \pm 0.21$	$3.25^{ab,wx} \pm 1.06$	$6.50^{a,w} \pm 2.12$	$7.00^{a,w} \pm 0.71$
	August			
Cage near water pad	0.33 ± 0.16	$0.52^{c} \pm 0.12$	$0.57^{c} \pm 0.16$	$0.68^{c} \pm 0.28$
Cage near fan	$0.52^{x} \pm 0.15$	$0.68^{c,x} \pm 0.03$	$1.17^{c,wx} \pm 0.51$	$1.60^{bc,w} \pm 0.26$
Air outlet	$0.27^{x} \pm 0.21$	$0.70^{c,wx} \pm 0.10$	$0.73^{c,w} \pm 0.06$	$0.73^{c,w} \pm 0.23$
Transverse feces collector	$0.83^{x} \pm 0.57$	$2.90^{ab,wx} \pm 0.85$	$5.07^{ab,w} \pm 1.69$	$5.07^{ab,w} \pm 0.75$
Longitudinal feces collector near water pad	0.60 ± 0.40	$1.50^{bc} \pm 0.70$	$1.77^{bc} \pm 1.45$	$2.37^{bc} \pm 2.97$
Longitudinal feces collector near fan	$0.90^{y} \pm 0.46$	$4.43^{a,x} \pm 1.40$	$5.60^{a,wx} \pm 1.91$	$7.73^{a,w} \pm 0.40$
	November			
Cage near water pad	$0.47^{ab,x} \pm 0.16$	$0.95^{ab,wx} \pm 0.17$	$1.52^{b,w} \pm 0.48$	$1.60^{c,w} \pm 0.10$
Cage near fan	$0.67^{ab,y} \pm 0.21$	$1.33^{ab,xy} \pm 0.68$	$1.88^{b,x} \pm 0.20$	$3.25^{bc,w} \pm 0.26$
Air outlet	$0.27^{b,x} \pm 0.12$	$0.77^{b,wx} \pm 0.25$	$1.17^{b,w} \pm 0.06$	$1.23^{c,w} \pm 0.38$
Transverse feces collector	$0.60^{ab,x} \pm 0.17$	$2.60^{ab,wx} \pm 0.69$	$4.33^{b,w} \pm 1.76$	$4.57^{bc,w} \pm 1.69$
Longitudinal feces collector near water pad	$0.27^{b,x} \pm 0.12$	$3.97^{ab,wx} \pm 3.57$	$4.40^{b,wx} \pm 2.71$	$5.83^{ab,w} \pm 2.57$
Longitudinal feces collector near fan	$0.83^{a,x} \pm 0.32$	$6.10^{a,wx} \pm 5.45$	$8.60^{a,w} \pm 1.35$	$9.00^{a,w} \pm 1.00$

Means ± S.D.

$^{a, b, c, d}$ Means in the same month within the same column without the same superscript are significantly different ($P < 0.05$).

$^{w, x, y}$ Means for the same sampling site within the same row without the same superscript are significantly different ($P < 0.05$).

表 3. 環控鴨舍內各季節與清洗後二氧化碳濃度之變化

Table 3. The change of carbon dioxide concentration in environment-controlled duck house in different season and time after washing

	Time after washing			
Sampling site	0 hr	24 hr	48 hr	72 hr
	CO_2 (ppm)			
	February			
Cage near water pad	401 ± 29	366 ± 99	419 ± 69	434 ± 51
Cage near fan	417 ± 62	381 ± 126	438 ± 87	467 ± 93
Air outlet	356 ± 71	332 ± 137	364 ± 80	427 ± 84
Transverse feces collector	408 ± 91	380 ± 147	447 ± 83	488 ± 71
Longitudinal feces collector near water pad	387 ± 42	364 ± 98	408 ± 52	428 ± 47
Longitudinal feces collector near fan	413 ± 75	382 ± 140	440 ± 76	483 ± 114
	May			
Cage near water pad	499 ± 30	485 ± 28	431 ± 75	469 ± 29
Cage near fan	559 ± 71	419 ± 128	508 ± 73	489 ± 27
Air outlet	532 ± 42	492 ± 56	500 ± 55	477 ± 44
Transverse feces collector	565 ± 62	542 ± 51	542 ± 37	537 ± 32
Longitudinal feces collector near water pad	461 ± 32	462 ± 78	469 ± 71	491 ± 26
Longitudinal feces collector near fan	518 ± 48	551 ± 39	542 ± 30	532 ± 33
	August			
Cage near water pad	424 ± 32	440 ± 20	450 ± 25	452 ± 22
Cage near fan	441 ± 22	465 ± 27	454 ± 22	461 ± 20
Air outlet	450 ± 17	437 ± 21	450 ± 51	420 ± 70
Transverse feces collector	455 ± 53	475 ± 18	464 ± 49	473 ± 30
Longitudinal feces collector near water pad	437 ± 39	379 ± 88	446 ± 42	435 ± 49
Longitudinal feces collector near fan	460 ± 47	455 ± 19	476 ± 17	466 ± 21
	November			
Cage near water pad	436 ± 43	395 ± 86	417 ± 36	439 ± 30
Cage near fan	458 ± 69	417 ± 35	441 ± 59	455 ± 37
Air outlet	431 ± 79	397 ± 80	393 ± 107	419 ± 52
Transverse feces collector	453 ± 80	448 ± 76	449 ± 81	468 ± 69
Longitudinal feces collector near water pad	429 ± 30	402 ± 43	420 ± 50	422 ± 66
Longitudinal feces collector near fan	444 ± 58	444 ± 78	452 ± 81	464 ± 67

Means ± S.D.

表 4. 環控鴨舍內各季節與清洗後風速之變化

Table 4. The change of wind velocity in environment-controlled duck house in different season and time after washing

Sampling site	Time after washing 0 hr	24 hr	48 hr	72 hr
	---------- Velocity (m/s) ----------			
	February			
Cage near water pad	$0.10^{b} \pm 0.10$	$0.17^{b} \pm 0.13$	$0.15^{b} \pm 0.22$	$0.05^{b} \pm 0.05$
Cage near fan	$0.13^{b} \pm 0.06$	$0.07^{b} \pm 0.08$	$0.23^{b} \pm 0.19$	$0.05^{b} \pm 0.09$
Air outlet	$5.40^{a} \pm 2.62$	$3.73^{a} \pm 1.63$	$3.23^{a} \pm 1.97$	$3.47^{a} \pm 1.27$
Transverse feces collector	$0.17^{b} \pm 0.12$	$0.33^{b} \pm 0.23$	$0.33^{b} \pm 0.15$	$0.43^{b} \pm 0.31$
Longitudinal feces collector near water pad	$0.30^{b} \pm 0.36$	$0.40^{b} \pm 0.10$	$0.27^{b} \pm 0.31$	$0.10^{b} \pm 0.17$
Longitudinal feces collector near fan	$0.33^{b} \pm 0.15$	$0.17^{b} \pm 0.21$	$0.23^{b} \pm 0.12$	$0.13^{b} \pm 0.12$
	May			
Cage near water pad	$1.00^{b} \pm 0.43$	$1.52^{b} \pm 0.08$	$1.42^{b} \pm 0.30$	$1.17^{b} \pm 0.35$
Cage near fan	$1.08^{b} \pm 0.60$	$1.48^{b} \pm 0.08$	$1.42^{b} \pm 0.18$	$1.18^{b} \pm 0.45$
Air outlet	$6.37^{a} \pm 0.10$	$5.67^{a} \pm 0.76$	$5.33^{a} \pm 2.08$	$6.43^{a} \pm 1.21$
Transverse feces collector	$0.77^{b} \pm 0.86$	$0.93^{b} \pm 0.47$	$1.27^{b} \pm 0.31$	$0.97^{b} \pm 0.51$
Longitudinal feces collector near water pad	$1.55^{b} \pm 0.21$	$1.70^{b} \pm 0.14$	$1.65^{b} \pm 0.21$	$1.25^{b} \pm 0.21$
Longitudinal feces collector near fan	$1.70^{b} \pm 0.00$	$1.45^{b} \pm 0.07$	$1.45^{b} \pm 0.35$	$1.35^{b} \pm 0.21$
	August			
Cage near water pad	$0.98^{b} \pm 0.37$	$1.17^{b} \pm 0.32$	$1.12^{bc} \pm 0.26$	$1.15^{b} \pm 0.18$
Cage near fan	$1.33^{b} \pm 0.10$	$1.15^{b} \pm 0.18$	$1.05^{bc} \pm 0.05$	$1.28^{b} \pm 0.23$
Air outlet	$5.33^{a} \pm 1.12$	$4.73^{a} \pm 0.59$	$5.67^{a} \pm 0.21$	$5.27^{a} \pm 2.10$
Transverse feces collector	$0.93^{b,wx} \pm 0.21$	$0.97^{b,wx} \pm 0.42$	$0.67^{c,x} \pm 0.31$	$1.37^{b,w} \pm 0.21$
Longitudinal feces collector near water pad	$1.57^{b} \pm 0.12$	$1.83^{b} \pm 0.31$	$1.40^{b} \pm 0.26$	$1.53^{b} \pm 0.35$
Longitudinal feces collector near fan	$1.83^{b,w} \pm 0.15$	$1.63^{b,wx} \pm 0.06$	$1.57^{b,x} \pm 0.12$	$1.57^{b,x} \pm 0.21$
	November			
Cage near water pad	$0.32^{b} \pm 0.17$	$0.25^{c} \pm 0.09$	$0.25^{b} \pm 0.22$	$0.18^{b} \pm 0.08$
Cage near fan	$1.03^{b} \pm 1.49$	$0.28^{bc} \pm 0.16$	$0.53^{b} \pm 0.33$	$0.28^{b} \pm 0.10$
Air outlet	$6.90^{a} \pm 0.00$	$7.60^{a} \pm 0.10$	$7.57^{a} \pm 0.58$	$7.07^{a} \pm 1.12$
Transverse feces collector	$0.27^{b} \pm 0.15$	$0.40^{bc} \pm 0.26$	$0.37^{b} \pm 0.35$	$0.23^{b} \pm 0.06$
Longitudinal feces collector near water pad	$0.53^{b} \pm 0.06$	$0.50^{bc} \pm 0.20$	$0.40^{b} \pm 0.26$	$0.37^{b} \pm 0.25$
Longitudinal feces collector near fan	$0.70^{b} \pm 0.35$	$0.80^{b} \pm 0.26$	$0.40^{b} \pm 0.37$	$0.50^{b} \pm 0.36$

Means ± S.D.

[a, b, c] Means in the same month within the same column without the same superscript are significantly different (P＜0.05).

[w, x] Means for the same sampling site within the same row without the same superscript are significantly different (P＜0.05).

表 5. 環控鴨舍內各季節與清洗後溫度之變化

Table 5. The change of temperature in environment-controlled duck house in different season and time after washing

	Time after washing			
Sampling site	0 hr	24 hr	48 hr	72 hr
	------------------------------ Temperature (℃) ------------------------------			
	February			
Cage near water pad	17.82 ± 1.29	17.08 ± 2.25	15.23 ± 1.24	15.35 ± 2.43
Cage near fan	18.08 ± 1.50	17.65 ± 2.73	15.85 ± 0.67	16.00 ± 2.70
Air outlet	19.27 ± 1.99	17.87 ± 3.09	15.23 ± 2.07	16.50 ± 2.27
Transverse feces collector	17.93 ± 1.27	17.60 ± 2.79	16.10 ± 1.66	16.33 ± 2.57
Longitudinal feces collector near water pad	17.40 ± 1.13	16.80 ± 2.03	15.10 ± 0.61	14.90 ± 1.91
Longitudinal feces collector near fan	17.73 ± 1.40	17.67 ± 2.86	15.73 ± 1.61	16.33 ± 2.90
	May			
Cage near water pad	23.68 ± 2.24	25.12^{bc} ± 0.35	24.02 ± 0.99	24.80 ± 0.22
Cage near fan	23.42 ± 2.31	24.58^{c} ± 0.16	24.02 ± 0.73	24.75 ± 0.20
Air outlet	24.40 ± 2.87	26.33^{a} ± 1.08	25.57 ± 0.83	25.33 ± 0.59
Transverse feces collector	23.40 ± 2.25	24.67^{c} ± 0.45	24.00 ± 0.44	24.83 ± 0.31
Longitudinal feces collector near water pad	24.70 ± 0.00	25.80^{ab} ± 0.42	25.55 ± 1.34	24.80 ± 1.27
Longitudinal feces collector near fan	24.65 ± 0.07	24.60^{c} ± 0.28	24.15 ± 0.64	24.70 ± 0.28
	August			
Cage near water pad	24.62^{ab} ± 0.44	25.18 ± 0.58	25.17 ± 1.01	25.60 ± 0.90
Cage near fan	24.65^{ab} ± 0.88	24.88 ± 0.51	25.58 ± 0.61	25.87 ± 0.81
Air outlet	26.17^{a} ± 1.01	26.20 ± 0.89	26.37 ± 0.55	26.43 ± 0.60
Transverse feces collector	$24.63^{ab, x}$ ± 0.55	25.17^{wx} ± 0.76	25.43^{wx} ± 0.38	26.73^{w} ± 0.85
Longitudinal feces collector near water pad	24.43^{ab} ± 0.29	25.73 ± 0.84	25.83 ± 1.59	25.43 ± 1.44
Longitudinal feces collector near fan	$24.37^{b,x}$ ± 0.23	24.83^{wx} ± 0.55	25.83^{wx} ± 0.76	26.20^{w} ± 0.79
	November			
Cage near water pad	19.42 ± 1.43	19.40 ± 1.75	18.62 ± 2.57	18.43 ± 1.62
Cage near fan	19.58 ± 1.80	19.42 ± 2.00	18.58 ± 2.39	18.23 ± 1.03
Air outlet	20.13 ± 3.52	19.07 ± 2.45	18.23 ± 2.20	17.50 ± 1.25
Transverse feces collector	19.80 ± 2.10	19.57 ± 1.96	18.37 ± 2.50	18.27 ± 1.20
Longitudinal feces collector near water pad	19.30 ± 0.90	19.33 ± 1.70	18.53 ± 2.41	17.93 ± 1.10
Longitudinal feces collector near fan	19.83 ± 1.95	19.50 ± 2.03	18.23 ± 2.41	18.20 ± 1.15

Means ± S.D.

$^{a, b, c}$ Means in the same month within the same column without the same superscript are significantly different (P＜0.05).

$^{w, x}$ Means for the same sampling site within the same row without the same superscript are significantly different (P＜0.05).

表 6. 環控鴨舍內各季節與清洗後濕度之變化

Table 6. The change of humidity in environment-controlled duck house in different season and time after washing

	Time after washing			
Sampling site	0 hr	24 hr	48 hr	72 hr
	------------------------------- Humidity (%) ---------------------------------			
	February			
Cage near water pad	92.62 ± 7.66	88.65 ± 13.45	79.47 ± 18.15	88.27 ± 10.43
Cage near fan	91.57 ± 8.82	88.27 ± 12.75	81.25 ± 16.82	88.92 ± 9.26
Air outlet	85.73 ± 12.81	83.90 ± 14.05	81.93 ± 19.24	82.53 ± 14.54
Transverse feces collector	95.10 ± 4.48	90.33 ± 10.35	82.83 ± 15.87	88.90 ± 9.10
Longitudinal feces collector near water pad	93.80 ± 5.70	88.77 ± 14.87	78.83 ± 18.37	88.83 ± 9.78
Longitudinal feces collector near fan	94.97 ± 4.78	88.57 ± 11.60	84.00 ± 15.47	90.07 ± 8.16
	May			
Cage near water pad	97.90 ± 3.64	95.32 ± 5.60	94.80^{ab} ± 3.12	92.92 ± 8.22
Cage near fan	98.33 ± 2.12	95.13 ± 5.12	96.75^{a} ± 5.46	93.53 ± 9.48
Air outlet	90.97 ± 10.14	89.73 ± 9.62	84.27^{b} ± 5.25	89.80 ± 10.41
Transverse feces collector	99.77 ± 0.40	97.13 ± 4.21	97.17^{a} ± 3.54	94.93 ± 7.76
Longitudinal feces collector near water pad	99.45 ± 0.78	95.55 ± 6.01	93.00^{ab} ± 1.98	96.25 ± 5.30
Longitudinal feces collector near fan	99.65 ± 0.49	99.80 ± 0.28	99.15^{a} ± 1.20	99.85 ± 0.21
	August			
Cage near water pad	98.43 ± 6.37	97.52^{ab} ± 1.81	97.95^{a} ± 1.85	99.73^{a} ± 0.46
Cage near fan	92.58 ± 6.69	99.15^{a} ± 0.52	96.55^{ab} ± 1.60	99.03^{a} ± 1.67
Air outlet	87.90 ± 11.16	91.53^{b} ± 3.27	87.70^{b} ± 4.16	89.83^{b} ± 3.67
Transverse feces collector	90.03 ± 8.75	96.77^{ab} ± 3.20	94.47^{ab} ± 4.99	97.23^{a} ± 4.79
Longitudinal feces collector near water pad	98.50 ± 1.35	96.13^{ab} ± 3.56	95.23^{ab} ± 4.91	100.0^{a} ± 0.00
Longitudinal feces collector near fan	94.30 ± 5.03	100.0^{a} ± 0.00	96.00^{ab} ± 3.12	100.0^{a,} ± 0.00
	November			
Cage near water pad	98.82 ± 1.26	98.60 ± 2.42	100.0 ± 0.00	97.27 ± 4.56
Cage near fan	99.32 ± 1.18	96.97 ± 5.25	100.0 ± 0.00	97.82 ± 3.78
Air outlet	91.03 ± 12.39	95.70 ± 7.45	100.0 ± 0.00	99.67 ± 0.58
Transverse feces collector	99.60 ± 0.69	96.43 ± 6.18	100.0 ± 0.00	99.07 ± 1.62
Longitudinal feces collector near water pad	100.0 ± 0.00	99.70 ± 0.52	100.0 ± 0.00	96.80 ± 5.54
Longitudinal feces collector near fan	100.0 ± 0.00	96.23 ± 6.52	100.0 ± 0.00	98.77 ± 2.14

Means ± S.D.

$^{a, b}$ Means in the same month within the same column without the same superscript are significantly different (P＜0.05).

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Establishment of the air pollution database in the environment-controlled duck house[1]

Chin-Hui Su[2] Jung-Hsin Lin[2][6] Ting-Hsun Hsiao[3]
Jeng-Fang Huang[2] Shuen-Rong Lee[5] and Meeng-Der Koh[4]

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Abstract

This study aimed to collect the basic data of odors in the environment-controlled duck house. The initiation of water-flow in the water pad and fans was subjected to the computer program. The concentrations of ammonia, methylamine, carbon dioxide, temperature, humidity and wind velocity were determined at 0, 24, 48, and 72 hrs after washing in different sampling sites in the duck house. The results showed concentrations of ammonia and methylamine tended to increase as time went on after washing, with the most striking increase observed in the excreta collector nearby the fans. The concentration of carbon dioxide were between 332 to 565 ppm. Wind velocities, temperature and humidity were mainly influenced by different season. In conclusion, the concentration of ammonia and methylamine in the environment-controlled duck house could be maintained in a low level by force ventilation.

Key words : Air pollutant, Duck house, Odour.

(1) Contribution No.1756 from Livestock Research Institute, Council of Agriculture, Executive Yuan.
(2) Ilan Branch , COA-LRI, Ilan 26846, Taiwan, R. O. C.
(3) Livestock Management Division, COA-LRI, Hsinhua, Tainan 71246, Taiwan, R. O. C
(4) Retired, Livestock Management Division, COA-LRI, Hsinhua, Tainan 71246, Taiwan, R. O. C.
(5) Retired, Ilan Branch , COA-LRI, Ilan 26846, Taiwan, R. O. C.
(6) Corresponding author, E-mail: ljh@mail.tlri.gov.tw