

Occurrence and Distribution of Fungal Isolates from Sputum, Ears and Nose Samples of Poultry Farm Workers in Anambra State, Nigeria

Mba Anthonia Nkiruka¹, Ekwealor Chito Clare^{1,*}, Ogbukagu Chioma Maureen¹,
Ekwealor Ikechukwu Amechi¹, Chukwuezi Fabian Okechukwu²

¹Department of Applied Microbiology and Brewing, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

²Department of Microbiology, Tansian University, Umunya, Anambra State, Nigeria

*Corresponding author: c.ekwealor@unizik.edu.ng

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Abstract Background: Poultry farming in Nigeria is one of the most lucrative jobs. It serves as source of animal proteins, provides employment and income for urban and rural dwellers, as well as manure for crop production. Unfortunately, the major challenge in the industry is fungal disease, which causes direct harm to the workers. This research was undertaken to isolate fungal organisms from sputum, ears and nose of poultry farm workers in Anambra State, study their seasonal occurrence and health effects on farm workers based on the open/floor and closed/caged systems practiced. **Materials and Methods:** A total of 1,120 human samples from 280 poultry farm workers in six Local Government Area of Anambra State were examined for fungal organisms. The samples were collected and cultured on Sabouraud Dextrose Agar plates, supplemented with 0.05mg/ml of chloramphenicol. The isolates were identified using macroscopic, microscopic and genetic features. The seasonal occurrences of the isolates based on open/floor and closed/caged systems were also determined. **Results:** Fungal isolates recovered from sputum during the dry season were only *Aspergillus* species, with *Aspergillus fumigatus* (49.0%) having the highest occurrence, while *Aspergillus* sp. (64.0%) and *Lichtheimia* (36.0%) were obtained in rainy season. Found in ear are mixed populations of fungi, mainly species of *Aspergillus* (81.9%), *Cunninghamella* (6.1%), *Paecilomyces* (19.0%), *Lichtheimia* (10.6%), *others* (26.4%) during dry and rainy seasons. In nasal samples, *Aspergillus* sp. (94.4%) and *Candida* sp. (5.6%) were observed in dry season, and species of *Aspergillus* (47.2%), *Lichtheimia* (34.4%), *Paecilomyces* (12.6%) and *Fusarium* (5.8%) recovered during rainy period. High fungal loads were observed in open/floor system than closed/caged system, and mainly during the rainy season. **Conclusion:** Poultry farm workers were observed to harbor different fungal organisms in their sputum, nose and ears, and some of them have been implicated in health hazards of the workers, hence the need to train them on good hygienic practices.

Keywords: poultry, farm workers, fungal isolates, human samples, seasonal variation

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1. Introduction

Fungal infections are among the most difficult diseases to manage in humans, with approximately 1.7 billion individuals suffering from these infections worldwide [1]. In recent years, they have emerged as a world-wide health care [2] especially in the poultry industry, causing direct harm to the workers as well as high morbidity, mortality and production losses [3,4]. Nevertheless, the industry has undergone phenomenal growth over the years. Fungi seem to be one of the great obstacles for poultry farmers, causing direct harm to human health due to their zoonotic implications and mycotoxin production [5]. Within the poultry house confinement, fungi may be present in settled

dust, bio-aerosols, derived from soil, grains [6], dust, droppings [7], moldy feed, especially processed ones and beddings, but to a lesser extent, from the birds themselves [8]. Fungal concentration in this environment vary greatly within a location and can significantly be modified depending on season, climate, time, space, characteristics of building, type of task, type of litter, poultry production, type of breeding, method of feed distribution, air flow velocity and type of system operated (open/floor and closed/caged system). Other factors that may determine the occurrence of fungi in the poultry farm include stocking density, health status of the animals. The type and degree of mycological contamination of the air in the poultry farm is also dependent on the sanitary and hygienic condition therein [9]. It is possible that persistent exposure of these workers to these fungal agents and

direct contact with infected birds increases the risk of infection, especially infections of the respiratory tract (mucous membrane irritation, invasive mycoses of lungs, allergic rhinitis, allergic pulmonary alveolitis, asthma), skin (dermatomycoses), ear (otomycosis) and nail bed (onychomycoses) [10].

Fungi in the genera *Acremonium*, *Fusarium*, *Lichtheimia*, *Aspergillus*, *Trichoderma*, *Penicillium*, *Scopulariopsis*, *Curvularia*, *Alternaria*, and yeasts such as, *Histoplasmosis*, *Cryptococcus* and most commonly *Candida* species, have been implicated in a number of diseases among poultry farmers [11]. There is paucity of information on ear and oral mycosis of poultry farmers but the majority of opportunistic oral mucosal fungal infections are due to *Candida albicans* and *Aspergillus* species especially *Aspergillus fumigatus*. *Mucor* (e.g *Lichtheimia corymbifera*) and *Cryptococcus* also have a major role in causing oral infections.

Otomycosis is caused by different fungal genera, mainly *Aspergillus* species and less commonly by *Candida* species and seen in the tropical and subtropical regions of the world [12]. There is scarcity of information on otomycosis among poultry farmers but clinical studies conducted in different countries: Algeria, Egypt, Arab and Nigeria, reported by [13], confirm that the saprophytic fungi: *Aspergillus niger*, *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus terreus*, *Aspergillus vesicolor*, *Candida albicans*, *Penicillium*, and *Mucor* are the main agents of otomycosis. Based on various studies, it is believed that fungi may cause otomycosis when the ear is in poor health [14], and prevalent among people of lower socioeconomic levels or under poor hygienic condition.

Aspergillus species are ubiquitous, their diseases have a worldwide distribution and may be found wherever environmental condition is favorable for fungal growth. They are common soil saprophytes and grow on organic matter in warm (>25°C) humid environments. Infection by fungi of this genera occurs more frequently in tropical countries. They cause Zoonotic infections which can be transmitted to man by handling infected birds and other animals [15]. Studies have shown that the most common of all *Aspergillus* species are *A. fumigatus* and *A. flavus* with *A. fumigatus* being considered as the major respiratory pathogen which can be contracted through spores that commonly colonize the upper and lower respiratory tracts, causing rhinosinusitis and pulmonary infection [16]. Other species like *A. niger*, *A. nidulans*, *A. terreus* may also be implicated in respiratory infections although sometimes as a mixed infection but much less frequently than *A. fumigatus*. Among the *Lichtheimia* species, *L. corymbifera* is the most important pathogenic species that causes significant human infection [17]. Inhalation is believed to be the main route of infection which commonly manifest in the respiratory tract. *Lichtheimia* species have also been implicated in the form of occupational hypersensitivity pneumonitis also known as Farmer's lung disease (FLD). The occurrence of FLD has been associated with increased number of *L. corymbifera* in the farm environment. This is caused by the sensitization to and repeated inhalation of organic antigens: poultry feathers and fecal material [7] contaminated with spores of *L. corymbifera*.

This work was, therefore, aimed at isolating and identifying fungi from sputum, ear and nose of poultry farm workers, determine their occurrence and seasonal distribution based on the open/floor and closed/caged housing systems practiced in most farms in Anambra State.

2. Materials and Methods

2.1. Description of Study Area

A large scale study was carried out on poultry and the farm workers in 10 poultry farms located in Anambra State, Southeastern part of Nigeria (Latitude 6° 20'N and Longitude 7°00'E). These 10 farms were visited between October, 2014 and September, 2015. The farms housing approximately 227,200 laying birds were examined. Six out of the 10 farms practiced open (floor) housing system while the remaining four practiced closed (cage) housing system.

2.2. Study Design

Validated questionnaires were developed to elicit information on the socio-demographic, physical and physiological health conditions of the poultry farmers as well as the management of the farms and flocks ie protective gears for the farmers (masks, gloves, coats, boots), number of hours spent in each day (full time/shift), how often the workers are trained, how they source water, how many times the farm and cages are cleaned, how often the food and water troughs are washed, how the equipment and environment are sanitized, how the birds droppings are managed.

2.3. Collection of Human Samples

The human samples were collected following the method described by [18]. Sputum samples (280) were collected from the poultry farmers early in the morning by expectoration into sterile, short, wide mouthed, screw capped, sampling bottles.

For the ear samples (560), both ears of the workers were swabbed and the swab stick replaced in the vial.

In the case of the nasal samples (280), the sterile swab was moistened with 0.9% saline solution and both noses swabbed.

All samples were labeled with the appropriate information (name and location of farm, name and age of farmer, source of collection, time and date), placed in sampling packets and transferred to microbiology laboratory, Nnamdi Azikiwe University, Awka, Anambra State. The samples were collected twice a week and the seasonal variation of the fungal load of the poultry farms during the dry and rainy seasons determined.

2.4. Cultivation of Fungi

Samples were inoculated into Sabouraud Dextrose agar plates, supplemented with 0.05mg/ml of chloramphenicol and incubated at 25°C. After 3-6days the plates were observed for fungal growth [19,20]. The fungal isolates

were sub-cultured and the pure cultures stored at 4°C in Sabouraud Dextrose Agar slants in test tubes for further studies.

2.5. Identification of Fungal Isolates

The fungal isolates were identified based on detailed studies of their colonial morphologies and microscopic features and compared to standard descriptions given by [21,22,23]. Some of the isolates were sent to Macrogen, Europe, Meibergdreef Amsterdam Netherlands, for proper identification and confirmation.

2.6. Statistical Analysis

The results and data obtained from the questionnaires distributed to the poultry farm workers were statistically analyzed using One-way Analysis of Variance (ANOVA) using SPSS version of 21 Software. Values were considered significant if $p < 0.05$.

Consent: Sample collection and filling of the questionnaires were voluntarily done on the site in each of

the farm, by the workers, with the permission of the management of the farms.

3. Result

As presented in Figure 1, mainly *Aspergillus* species were isolated from sputum during the dry and rainy seasons. *Aspergillus fumigatus* (49.0%) had the highest occurrence during the dry season while *Aspergillus flavus* (31.0%) and *Lichtheimia corymbifera* (36.0%) occurred more in rainy season.

The isolates from ear of poultry farm workers are shown in Figure 2. A high percentage of *Aspergillus* species was observed from the ears of the workers with *Aspergillus fumigatus* (37.4%) and *Aspergillus niger* (21.0%) in dry and rainy seasons respectively being of highest occurrence. Species of *Cunninghamella*, *Nathrasia*, *Stachybotrys* and *Trichoderma* were found only during the dry season while species of *Lichthermia* (10.6%), *Acremonium* (4.8%), *Paecilomyces* (19.0%), *Chrysonilia* (4.8%) and *Fusarium* (4.8%) were isolated only in rainy season.

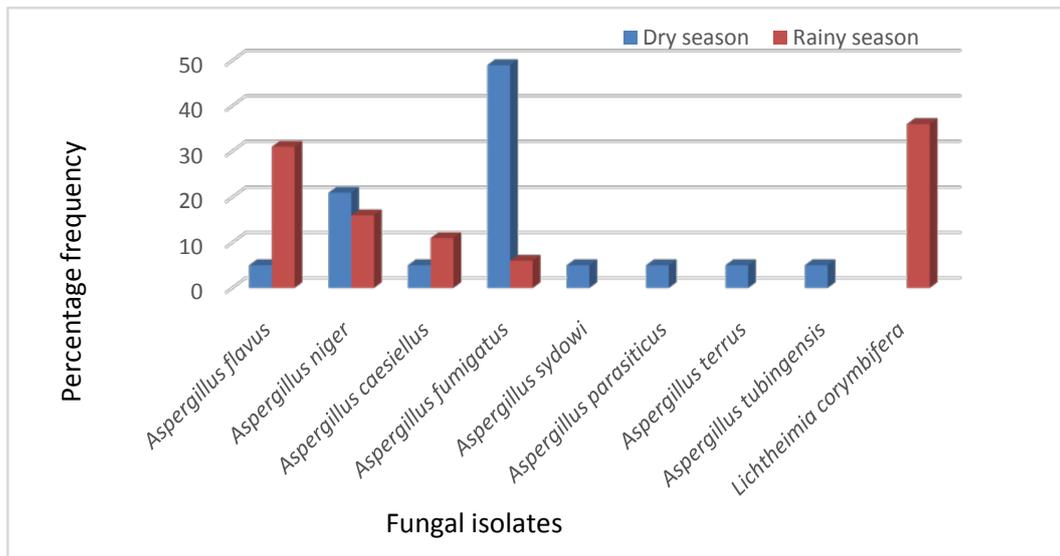


Figure 1. Percentage frequency of fungal isolates from sputum of poultry farm workers during dry and rainy seasons

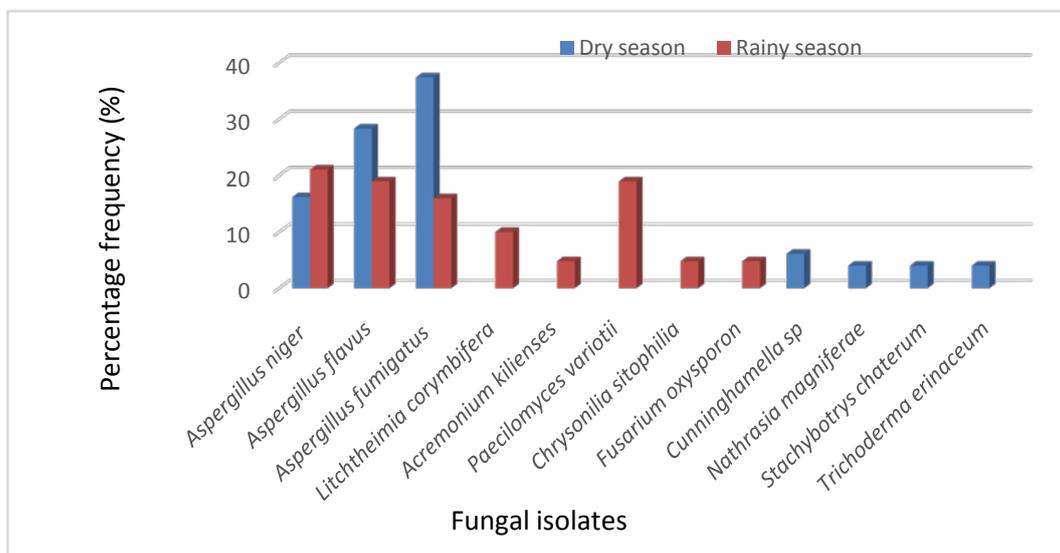


Figure 2. Percentage frequency of fungal isolates from ear of poultry farm workers during dry and rainy season

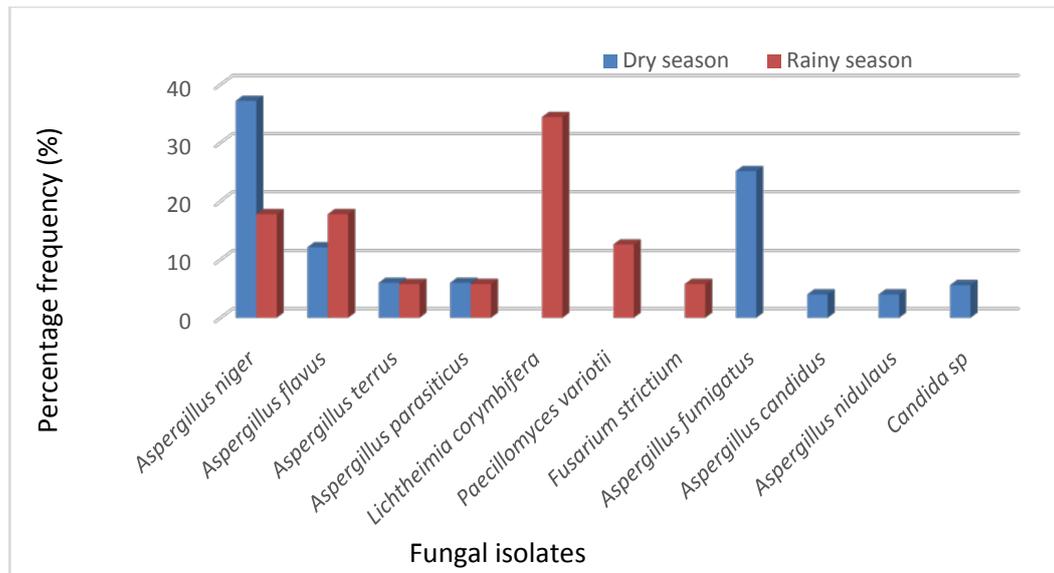


Figure 3. Percentage frequency of fungal isolates from nose of poultry farm workers during dry and rainy season

Table 1. Seasonal variations of fungal loads in farms practicing open/floor and closed/cage systems in Anambra State

Season/Fungal load (cfu/m ³)		Location of farm	Types of litter	Types of system
Dry	Rainy	Town/Local Government		
2.29×10 ³	3.80×10 ⁵	Umuoji/Idemili North	Recycled Droppings	Open/Floor
1.93×10 ²	8.35×10 ³	Ogidi/Idemili North	Wood Shaving	Open/Floor
4.60×10 ²	3.23×10 ³	Onitsha/Onitsha North	None(Cemented)	Open/Floor
1.24×10 ³	6.83×10 ⁴	Nnewi/ Nnewi North	Saw Dust	Open/Floor
9.40×10 ¹	1.21×10 ²	Nteje/Oyi	Not Applicable	Closed/Cage
8.01×10 ¹	1.55×10 ²	Uga/Agwata	Not Applicable	Closed/Cage

Figure 3 shows the isolates from the nose of the poultry workers, *Aspergillus* sp (94.4%) and *Candida* sp (5.6%) were observed to occur in dry season. Although *Aspergillus* sp. (47.2%) were in abundance during the rainy season, other species of fungi isolated include *Lichtheimia* (34.4%), *Paecilomyces* (12.6%) and *Fusarium* (5.8%).

Considering the seasonal variation of the fungal isolates from sputum, ear and nose, *Aspergillus* species seem to play a dominant role in both dry and rainy seasons, while species of *Lichtheimia corymbifera* was isolated only during the rainy period (Figure 1 - Figure 3).

Table 1 shows the seasonal variations of fungal loads in farms that practice open/floor and closed/cage systems in six local governments of Anambra State. 66.7% of the farms practiced open/floor housing system while 33.3% practiced close/cage housing system. As observed (Table 1), high fungal loads were found in open/floor system than closed/cage system, and mainly during the rainy season. The highest fungal load of 3.80×10⁵ cfu/m³ was observed during the rainy season in open/floor system in Umuoji town of Idemili North local government area that uses recycled droppings as its litters.

4. Discussion

The prevalence of fungal organisms among poultry farm workers as suggested by [2,24] may have been as a

result of their susceptibility to contaminated environment and inhalation of high level of dust particles containing fungal spores during handling and processing of contaminated materials.

The results of the fungal isolates from sputum show that during rainy season, only two genera were isolated, *Aspergillus* species (65%) and *Lichtheimia corymbifera* (35%). Among the *Aspergillus* species, *A. flavus* (30%) had the highest occurrence (Figure 1). During dry season, only *Aspergillus* species were isolated with *A. fumigatus* (48%) being the highest.

Previous work by [25], on the fungal isolates present in sputum of poultry workers' showed the presence of only *Aspergillus* species during dry season. Reference [2], also isolated *Aspergillus* species (23.3%) from sputum samples of poultry farmers during dry season. These authors as well as [26], noted that *A. fumigatus* was the predominant fungi. These findings are supported by the results obtained in this study. The presence of *Aspergillus* in sputum has been reported by many workers. References [27,28] isolated *Aspergillus fumigatus* from sputum of patients with pulmonary aspergillosis and history of asthma. Similarly [29], reported the presence of *Aspergillus* species, precisely *A. niger* and *A. fumigatus* in the sputum of poultry farm workers but noted that these organisms were isolated more from the farm workers than the farm owners and veterinarians. The reason for this may have been as a result of the exposure rate of the farm workers to the birds. Since *Aspergillus* infections and isolation

from susceptible host occur as a consequence of high concentration of conidia and long term exposure [30,31], the absence of this fungus in sputum of the farm workers as examined by [32], may be attributed to low density birds within the farm, residence of the farmers and level of personal hygiene of the farm workers.

Fungi have been observed to attack the ear of poultry farmers causing otomycosis. Study of the ear of the workers showed the presence of *Aspergillus* species (63.81%) with *A. niger* (18.97%) occurring higher than the other species during rainy season (Figure 2). The presence of *Paecilomyces variotii*, *Lichtheimia corymbifera*, *Acremonium kiliensis*, *Fusarium oxysporum* and yeast was also recorded. *Aspergillus* species (78.78%) was observed to occur higher than other isolates during dry season (Figure 2). The result obtained in this study is in line with the work of [30], who also isolated higher *Aspergillus* species (35%) from the ear of poultry farm workers than other fungal species. References [30,32], recorded the prevalence of *A. fumigatus*, 27.3% and 37.5% respectively, during dry season and these findings are supported by the results obtained in this study, in which *A. fumigatus* (37.4%) was observed during dry season. Presence of *Aspergillus* species observed in the ears of the poultry farm workers supports the work of [33], who reported that *A. flavus*, *A. fumigatus* and *A. niger* can be isolated from the ear of poultry farm workers, and as stated by [34,35,36,37,38], that if condition becomes favourable, they can cause otomycosis.

Other fungal organisms isolated include *Cunninghamella bertholletiae* (6.10%), *Nathrasia mangiferae* (4.0%), *Stachybotrys chaterum* (4.0%) and *Trichoderma erinaceum* (4.0%). The occurrence of these fungal isolates in the ear of the poultry workers as observed in this study, is likely to be dependent on the presence and level of contamination produced in these farms, length of time the workers spent within these farms and the season. It was observed that more number of isolates and fungal load were obtained from those who lived within the farms and also spent more time there, during the rainy season than the dry season.

It has been suggested by [39,40], that the type of production, housing systems, and tasks performed, have significant influence on the level of exposure to environmental contaminants in workers, which has an impact on their respiratory health. *Aspergillus* species along with other isolates were observed in the nose of the workers during rainy season. *A. niger* and *A. flavus* were seen to be the highest in occurrence (Figure 3). [41], reported that the distribution of fungal species in the nose was in the sequence of *A. niger*, *A. fumigatus* and *A. flavus*. [42,43], also made similar observation. Only *Aspergillus* species (94.4%) and *Candida* species (5.6%) were isolated from the nose of the farm workers during dry season (Figure 3). Among the *Aspergillus* species, *A. niger* (37.2%) had the highest occurrence. Although the seasonal occurrence of their isolates was not reported, [30], observed that 40% of human nasal swabs from the farm workers were positive for *Aspergillus* species. However, contrary to our findings, they noted that *A. fumigatus* had the highest occurrence.

Mucorales are ubiquitous and humans are usually infected through inhalation of conidia. Figure 3, shows a

high level of occurrence of *Lichtheimia corymbifera* (34.4%) in the nose of some of the poultry workers during rainy season. This supports the work of [44], who noted the ubiquitous nature of *Mucorales* in poultry farms.

The occurrence and distribution of the different genera of fungi in the nose was observed to be statistically significant ($P < 0.05$). There was no significant difference ($P > 0.05$), in the occurrence of fungal isolates within the various body sites of the poultry farm workers (sputum, ear and nose), but a significant difference ($P < 0.05$) in the seasonal occurrence of the fungal isolates within the various body sites (sputum, ear and nose) was observed.

Most of the workers examined had poor educational background; a good number of them stopped at secondary (37.14%) and primary (35.71%) levels while a few others had tertiary educational background (27.15%), but without any training, and therefore, had little or no knowledge of the risks associated with poultry farming.

The two poultry operations known are closed/caged and open /floor system and differ in a number of ways including the time spent by workers in bird houses, the age of birds and the housing management practices.

As shown in Table 1, the open/floor system has high fungal load than the closed/cage system. The high prevalence rate of fungi isolated from these poultry farm workers may have resulted from high level of contaminants and activities in the open floor housing system, practiced in most of the farms studied. As observed by [8], workers in cage-based systems usually spend less time in the poultry houses and are associated with reduced duration of exposure and possibly reduced risk of adverse health effects. Similarly [45,46], reported that workers in open/floor housing poultry operations had significantly greater exposure to bio-aerosols.

In an interaction with the poultry farm workers in the closed/caged housing system, few of them complained of symptoms associated with the presence of fungi in poultry farm, such as headache(30%), muscular pain (7.1%), chest tightness(24%), coughing (30%) sneezing (7%), burning and watery eyes (25%), excessive tearing (10%) and plugged ear (15%), which were common among the workers in the farms that practiced open/floor housing system. However, [46] observed that workers in closed/caged housing poultry operation showed greater prevalence of respiratory symptoms despite the low level of contaminants and activities in this type of housing system.

5. Conclusion

This study has shown that the poultry farm workers harbor different types of fungal organisms. *Aspergillus* species were observed to be the most predominant fungi isolated from sputum, nose, ears of these workers during the rainy and dry seasons while *Lichtheimia* sp. were predominantly recovered from the three sites during the rainy season. The proliferation of these organisms was encouraged by open/floor housing system operated in most of the poultry farms, and some of these organisms have been implicated in health hazards. There is need, therefore, for the farmers to be trained on farm

management in order to protect themselves on the health risk associated with the industry

References

- [1] Rauseo, A. M., Ariella, C., Lindsey, L. and Andrej, S. Hope on the Horizon: Novel Fungal Treatments in Development. *Open Forum Infectious Diseases* 7(2): ofaa016, Jan. 2020.
- [2] Lobna, M. A. S. and Abdel, A. F. Epidemiological study of Aspergillosis in chickens and human contacts in chicken farms at Kalyoubia Governorate. *IOSR Journal of Agriculture and Veterinary Science* 7(7): 20-24, July 2014.
- [3] Sajid, M. A., Khan, I. A. and Rauf, U. *Aspergillus fumigatus* in Commercial Poultry Flocks, A Serious Threat to Poultry Industry in Pakistan. *Journal of Animal and Plant Sciences* 16(3-4): 79-81, March 2007.
- [4] Kuldeep, D., Sandip, C., Anut, K. V., Ruchi, T., Rajamani, B., Amit, K. and Shambhu, D. S. Fungal mycotic diseases of poultry diagnosis, treatment and control: A review. *Pakistan Journal of Biological Sciences* 16: 1626-1640, Dec. 2013.
- [5] Kwanashie, C. N., Kazeem, H. M. Abdu, P. A. and Umoh, J. U. Distribution of *Aspergillus* species among apparently healthy birds in poultry farms in Kaduna State, Nigeria. *Scientific Journal of Microbiology* 2(3): 61-66, 2013.
- [6] Seyedmousavi, S., Bosco, S. D. M. G., de Hoog, S., Ebel, F., Elad, D., Gomez, R. R., Jacobsen, I. D., Jensen, H. E., Martel, A., Mignon, B., Pasmans, F., Pieckova, E., Rodrigues, A. M., Singh, K., Vicenta, V. A., Wibbett, G., Wiederhold, N. P. and Gullot, J. Corrigendum: Fungal infections in animals: a patchwork of different situations. *Medical Mycology*. 56(8): 165-187, Nov. 2018.
- [7] Taluja, M. K., Gupta, V., Sharma, G. and Arora, J. S. Prevalence of symptoms (respiratory and non respiratory) among poultry farm workers in India. *American Journal of Physiology, Biochemistry and Pharmacology* 8(2): 40-46, Oct. 2018.
- [8] Ngajilo, D. Respiratory health effects in poultry workers *In: Allergies in the workplace. Current Allergy and Clinical Immunology*, 27(2): 116-124, June 2014.
- [9] Grzyb, J. and Leinart-Boron, A. Size, distribution and concentration of fungal aerosol in animal premises of a zoological garden. *Aerobiologia*, Jan. 2020.
- [10] Sowiak, M., Brodka, K., and Buczynska, A. An assessment of potential exposure to bioaerosols among swine farm workers with particular reference to airborne microorganisms in the respirable fraction under various breeding conditions. *Aerobiologia* 28(2): 121-133, July 2012.
- [11] Cramer, R., Weichel, M., Flückiger, S., Glaser, A.G. and Rhyner, C. Fungal allergies: yet unsolved problem. *Chemical Immunology and Allergy*, 91: 121-133, 2006
- [12] Singh, M., Mittal, N. and Kakkar, M. Otomycosis: A clinicomycologic study. *Ear, Nose and Throat Journal* 78(8) 606-609, Aug. 2000.
- [13] Zakaria, A. and Hamze, M. Recent trends in the epidemiology, diagnosis, treatment and mechanisms of resistance in clinical *Aspergillus* species: A general review with a special focus on the middle Eastern and North African region. *Journal of Infection and Public health* 13(1): 1-10, Jan. 2020.
- [14] Fasunla, J., Ibeke, T. and Onakoya, P. Otomycosis in Western Nigeria. *Mycoses* 51(6): 67-70, Jan. 2008.
- [15] Girma, G., Abebaw, M., Zemene, M., Mamuye, Y. and Getaneh, G. A review on Aspergillosis in poultry. *Journal of Veterinary Science Technology*, 7: 382, 2016.
- [16] Cho, H., Lee, k. H., Colquhoun, A. N. and Evans, S. A. Invasive oral aspergillosis in patient with acute myeloid leukemia. *Australia Dental Journal* 55:214-218, August 2010.
- [17] Schwartz, V. U. and Jacobse, I. D. Mucormycoses caused by *Lichtheimia* species. *Mycoses* 57(3)73-78, 2014.
- [18] Brekke, B. and Hartley, J. Specimen collection- Microbiology and Virology. Bit.ly/GOSHSspecimen, 2014.
- [19] Krnjaja, V., Paviovski, Z., Lukie, M., Skrbic, M., Stojanovic, L. J., Bijelic, Z. and Mandic, V. Fungal contamination and natural occurrence of ochratoxin A (OTA) in poultry feed. *Biotechnology In Animal Husbandry*, 30(3): 481-488, Sept. 2014.
- [20] Pavan, R. and Manjunath, K. Indoor and outdoor air quality of poultry farm at Bangalore. *International Journal of Pharmaceutical and Biological Sciences*, 5(4): 654-665, Oct. 2014
- [21] De Hoog, G. S., Guarro, J., Gene, J. and Figueras, M. J. *Atlas of Clinical Fungi*, 2 (1). Central bureau voor Schimmel cultures, Utrecht, The Netherlands, August 2000.
- [22] Diba, K., Kordbacheh, P., Mirhendi, S. H., Rezaie, S., and Mahmoudi, M. Identification of *Aspergillus* species using morphological characteristics. *Pakistan Journal of Medical Sciences*, 23(6): 867- 872, Oct. - Dec. 2007.
- [23] Nadia, E. A., Ibtissem, B. S., Mohamed B. K., Mahmoud, M. and Naima, B. Isolation and identification of fungal communities in organic and conventional soils. *International Journal of Current Microbiology and Applied Sciences*, 6(4): 1111-1123, April 2017.
- [24] Sabino, R., Faisca, V. M., Carolino, E., Verissimo. C. and Viegas, C. Occupational exposure to *Aspergillus* by swine and poultry farm workers in Portugal, *Journal of Toxicology and Environmental Health Part A*, 75:1381-1391, Oct. 2012.
- [25] Denning, D. W., Pashley, C., Hartl, D., Wardlaw, D., Godet, D., Giacco, S. D., Delhaes, L. and Sergejeva, S. Fungal allergy in asthma—state of the art and research needs. *Clinical and Translational Allergy*, 4:14, April 2014.
- [26] Bater, J. R., Flack, M. R., Clotti, S.M. and Sutcliffe, A. J. Methods of treating fungal, yeast and mold infections. <https://www.google.com/patents/US8226965>, July 2013.
- [27] Stinghe, R., Zoi, A., Kercea, V. and Vesiloch. V. *Journal Francais De Medecine Et Chirurgie Thoraciques*, 23(6):581, 1969.
- [28] Jordan, M., Bierman, C. W. and Van, A. Aspergillosis in chickens and human contact. *Archives of Internal Medicine*, 128(4): 56-57, 1971
- [29] Mona, S. Zaki, Suzan O. Mostafa and Nagwa S. Rabie. Aspergillosis in chickens and human contacts. *Der Pharmacia Lettre*, 8 (12):216-220, 2016.
- [30] Claudia, C., Antonio, C., Roberta, L., Patricia, D., Vincenza., F., Giancarlo, D., Nicola,P., Anna, C., Maria, T. and Domenico, O. Environmental contamination by *Aspergillus* spp. in laying hen farms and associated health risks for farm workers *Journal of Medical Microbiology*, 63(3):464-470, March 2014.
- [31] Binder, U. and Lass-Flörl, C. Epidemiology of invasive fungal infections in the Mediterranean area. *Mediterranean Journal of Hematology and Infectious Diseases* 3e20110016, 2011.
- [32] Radwan, I. A., Kamel, M. F., Hamdy, D. A. and Mahmoud, Z. A. Correlation between *Aspergillus fumigatus* isolates recovered from human and broiler chickens. *Journal of Veterinary Medicinal Research* 26(1): 64-75, April 2019
- [33] De Lucca, J. A. Harmful fungi in both agriculture and medicine. *Revista Iberoamericana de Micologia* 24:3-14, April 2007.
- [34] Kaur, R., Mittal, N., Kakkar, M., Aggarwal, A. K., and Mathur, M. D. Otomycosis: a clinicomycologic study. *Ear Nose Throat Journal* 79: 606- 609, Aug. 2000.
- [35] Kurnatowski, P., and Kilipiak, A. Otomycosis: prevalence, clinical symptoms, therapeutic procedure, *Mycoses* 44:472-479, Jan. 2001.
- [36] Nwabuisi, C. and Ologe, F. E. The fungal profile of otomycosis patients in Ilorin, Nigeria. *Nigerian Journal of Medicine* 10: 124-126, July 2001.
- [37] Paulose, K. O., Al Khalifa, S., Shenoy, P. and Sharma, R. K. Mycotic infection of the ear (otomycosis): a prospective study. *Journal of Laryngol Otolary*, 103: 30-35, Jan. 1989.
- [38] Vennewald, I., Schonlebe, J. and Klemm, E. Mycological and histological investigations in humans with middle ear infections. *Mycoses* 46:12-18, Feb. 2003.
- [39] Lonc, E. and K. Plewa, K. Microbial air contamination in poultry houses. *Polish Journal of Environmental Study*, 19(1): 15-19, Aug. 2010.
- [40] Kostadinova, G., Petkov, G., Dene, S., Miteva, C. H., Stefanova, R. and Penev, T. Microbial pollution of manure, litter, air and soil in a poultry farm in Bulgarian *Journal of Agricultural Science*, 20(1): 56-65, Dec. 2014.
- [41] Venkateswarlu, V. A study of fungal infections in ear, nose and throat. *Magnetic Resonance in Medical Science Journal* 3(2): 100-103, 2015.
- [42] Kondity, V. P., Murahari, S. S. R. and Anke, G. A study of mycotic ear infection in a tertiary care hospital *International Journal of Current Microbiology and Applied Science*, 4(11): 511-516, 2015.

- [43] Al-Bayati, F. A., Muhammed, A. A. and Al-Watta, W. M. Detection of *Aspergillus* species from ear and nose swabs in a group of iraqi diabetes mellitus patients. *Journal of Bio-Science and Biotechnology*, 5(3): 281-287, 2016.
- [44] Crum-Cianflone, H. F. and Pranatharthi, H. C. Mucormycosis. *Medscape*. 2015 <http://emedicine.medscape.com/article/222551-overview>. Retrieved September 20, 2016.
- [45] Kirychuk, S. P., Dosman, J. A., Reynolds, S. J., Willson, P., Senthilselvan, A., Feddes, J. J., Classen, H. L. and Guenter, W. Total dust and endotoxin in poultry operations: comparison between cage and floor housing and respiratory effects in workers. *Journal of Occupation and Environmental Medicine*, 48: 741-748, July 2006
- [46] Just, N., Blais-Lecours P., Marcoux-Voisella M., Kirychuk, S., Veillette, M., Sing, B., Duchaine, C., Archeal characterization of bioaerosols from cage-housed and floor housed poultry operations. *Canadian Journal of Microbiology* 59(1): 46-50, Jan. 2013.



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