REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

Prevention of Avian Crop Candidiasis by Dietary Supplementation of Saccharomyces Cerevisiae

Zaid Yaseen Ibrahim[1], **Natheer Ahmad Hameed**[2], **Ahmed Sami Jarad** [3]
[1,3] University of Fallujah / College of Veterinary Medicine, Iraq, Fallujah,
[2] Almaarif University College / Department of Nursing/Iraq
drzaidvet@gmail.com

Abstract

Candidiasis is a fungal disease of many avian species caused by the polymorphic yeast Candida albicans. These yeasts are normal flora in the upper digestive system of birds, they cause disease when the bird suffers from debilitating conditions. The yeast Saccharomyces Cerevisiae that is commonly used for baking and brewing has been used as an alternative for antibiotics and as a growth promoter in poultry and has been proved successful in treating oral and vaginal candidiasis in human. Our study was conducted as an attempt to find an alternative method for treating candidiasis in avian hosts using the readily available yeast Saccharomyces Cerevisiae. A number of 80 broilers were divided into 4 groups. Group 2 was fed a ration contained Saccharomyces Cerevisiae. Group 3 was challenged with oral Candida albicans. Group 4 treated with both organisms while group 1 was considered control and did not receive any treatment. The experiment started at one day old and continued for 9 days. Crops were examined grossly and histologically at the end of experiment. Crops appeared normal in both group 1 and 2, while in group 3 they were thickened with diphtheritic pseudomembrane grossly and fungal hyphae, pseudohyphae and spores proliferated within squamous epithelia and lamia propria histologically. In group 4 they showed markedly less macro and microscopic changes. This treatment was found effective in controlling crop candidiasis in birds.

Keywords: Candida albicans, Saccharomyces Cerevisiae, Broiler poultry

Introduction

Candidiasis is a fungal disease caused by the polymorphic yeast belonging to the genus Candida. Although there are many candida species that cause candidiasis, Candida albicans is the main species that is accused for causing the disease (2). Candidiasis has been documented in many avian species including domestic and wild birds (15,19,26,31,36,37). Candida species are normal inhabitants in the upper digestive system of birds, and when the bird suffers from debilitating conditions it will cause a severe illness. It also occurs when there is a decrease in the number of microflora due to prolonged antimicrobial use. All these conditions will give candida a chance to replicate beyond the normal rate (28).

Candidiasis occurs mostly in young birds. Affected birds will grow slowly and will have abnormal appearance with rough feathers. Lesions are seen mostly in the crop. These lesions are patches of whitish necrotic exudates that sometimes become larger forming pseudomembranes that may cover a large portion of the mucosal lining of the crop (15). The gross lesion is usually described as crud-like or turkish towel like appearance. Microscopically, there is colonization of the crops keratinized epithelium with Candida's septate hyphae (2,15).

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

A history of long term administration of antimicrobial therapy along with typical gross lesion can aid in the initial diagnosis of the disease. Confirmation of diagnosis is made by cultivation of the organism on Sabouraud agar but initial heavy growth is necessary for diagnosis because the organism present in small numbers in healthy birds. A wet mount preparation from the lesion can be used for the diagnosis based of visualization of budding candida cells (7,29). The disease is treated effectively by 0.05% copper sulfate in drinking water. Nystatin in feed and in drinking water is also used for treating of candidiasis (2).

The yeast Saccharomyces Cerevisiae that is commonly used for baking and brewing has been used as an alternative for antibiotics as a growth promoter (22,40). Other than increasing feed conversion ratio (FCR), these yeasts are used to modulate the immune system and reducing the numbers of gastrointestinal pathogens in livestock (30). In poultry production, Saccharomyces Cerevisiae has been proved to increase FCR in broilers and increase the quality and quantity of egg production in layers (1,3,5,6,8–11,14,18,20,21,23,24,32–35,39).

The use of some non-pathogenic microbes for the treatment of microbial infections has shown promising success in some studies (38). Examples for such studies include: treating Clostridium difficile infection in mice by Clostridium scindens and the use of Lactobacilli for the treatment of vulvovaginal candidiasis in women (4,12). Saccharomyces Cerevisiae has been proved successful in treating oral and vaginal candidiasis in human (13,16,25,27,38). Due to the lack of previous literature examining the effect of Saccharomyces Cerevisiae on animal candidiasis, our study was conducted as an attempt to find an alternative method for treating candidiasis in avian hosts using the readily available yeast Saccharomyces Cerevisiae.

Materials and Methods

Candida albicans was isolated from a clinical candidiasis in a local rooster. There was diphtheritic lesion on the oropharyngeal, esophageal and crop mucosa. Swabs from lesions were streaked to Sabouraud agar containing mixture of antibiotics and incubated aerobically at 37°C for 2 days. Confirmation of the species Candida albicans was based on the characters described by Quinn et. al. (2011).

A number of 80 cornish cross broilers were purchased from a local poultry hatchery. They were divided into 4 groups each one consisted of 20 chicks. At the age of one day, group 2 (G2) was fed a ration contained 2% bakers yeast Saccharomyces Cerevisiae. This concentration was found to increase FCR in previous studies (34). G3 was challenged with oral Candida albicans at the dose of 3×10^9 colony forming units (CFU) per chick at day old. This dose was based on a pilot study that was conducted prior to the experiment. G4 treated with both organisms at the same age while G1 was considered control and did not receive any treatment (Table 1).

The study was conducted at the College of Veterinary Medicine at the University of Fallujah, Iraq during the period from December 1, 2019 to March 20, 2020. The experiment continued for 9 days then a random sample from each chicks group was collected. The weight of birds was recorded and the chicks were humanly euthanized for gross and histopathological

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

examination. Tissue sections from the crop were prepared and stained with hematoxylin and eosin stain (HE) and Periodic acid–Schiff stain (PAS) according to Luna (1968).

Table 1: Names of the experiment chick groups. The + sign under treatment indicate that the corresponding group has been treated with Saccharomyces Cerevisiae. The + sign under infection indicate that the corresponding group has been challenged orally with Candida albicans.

Groups	Treatment	Infection
G1	-	-
G2	+	-
G3	-	+
G4	+	+

Results and Discussion

Mycology

Microbial characteristics of Candida albicans was typical to those described by Quinn et. al. (2011). They were isolated on Sabouraud agar. Colonies were whitish, shiny and 4-5 mm in diameter. When the organism examined directly under a light microscope a characteristics budding cells were seen. For further confirmation, germ tube formation and chlamydospores formation was tested. Germ tube formation was demonstrated after incubation in serum at 37°C for 2 hours. Germ tubes are pseudohyphae emerging from the yeast cell give the organism a sperm appearance. For the visualization of chlamydospores the organism was cultured on corn meal agar for several days. Chlamydospores are circular cells thar easily distinguishable from the oval budding cells and have thicker walls ().

Pathology

On necropsy, crops from G1 and G2 had thin walls and shiny pinkish-brown mucosae (). Histologically, the epithelium appeared normal with no inflammatory cells infiltration (). G3 crops were grossly thickened and a whitish to yellowish diphtheritic pseudomembrane covered a large portion of the mucosal surfaces (). Histological sections of these crops revealed fungal hyphae, pseudohyphae and spores proliferated within squamous epithelia and lamia propria (and). Tissue reaction consisted of sever inflammatory response within sub mucosa, lamina properia and musclaris mucosa (). The epithelium was ulcerated and invaded by inflammatory cells. On the margins of the ulcer there was intercellular edema, dissociation, necrosis, and exfoliation of keratinocytes (). These lesions are typical to candidiasis that were reported in many previous studies (2,7). Our finding disagree with fulan et al who reported minimal inflammatory reaction in cases of candidiasis.

Group 4 that were fed a ration containing 2% Saccharomyces Cerevisiae showed markedly less intensive gross lesion when compared to G3. The lesion consisted of small patches of crud-like exudate (). Histopathological examination of crop from G4 showed limited fungal

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

infestation of squamous layer and heavy spore accumulation within crop lumen (). The limited fungal penetration of the crop epithelium could be explained by a competitive exclusion of the Candida albicans by the yeast cells of Saccharomyces Cerevisiae. This hypothesis has also been suggested by other workers who found similar effect of this treatment to human patient suffering from oral and vaginal candidiasis (13,27).

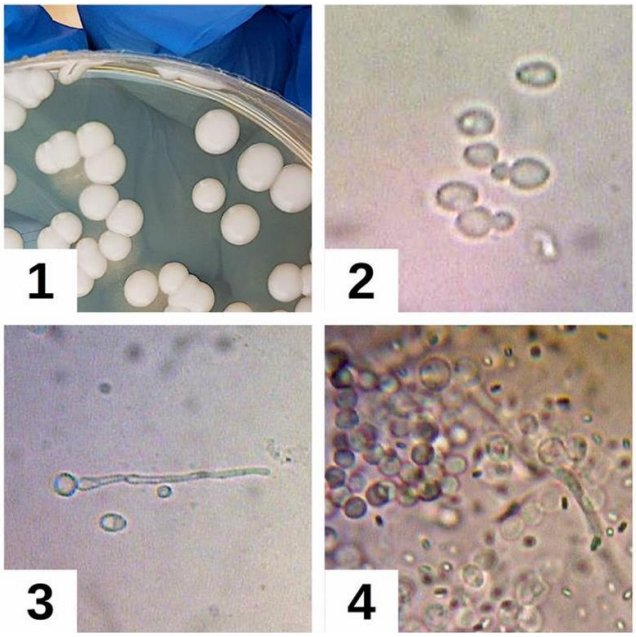

Figure 1: Mycological characters of Candida albicans: (1) Colonies appeared whitish, shiny and 4-5 mm in diameter on Sabouraud agar. (2) Budding cells were seen when a wet mount smear is prepared from colonies. (3) Germ tube formation was demonstrated after incubation in serum at 37°C for 2 hours. (4) Chlamydospores were seen when the organism was cultured on corn meal agar for several days.

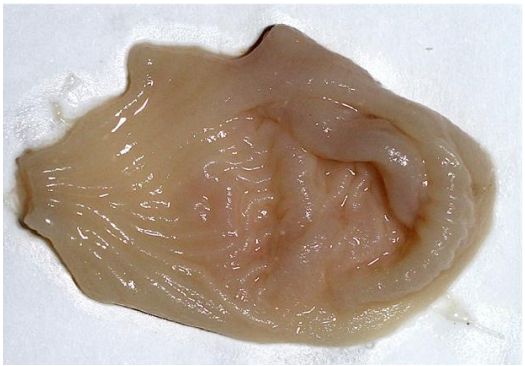

Figure 2: A photographic image showing the normal gross appearance of a crop from control chicks of G1.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

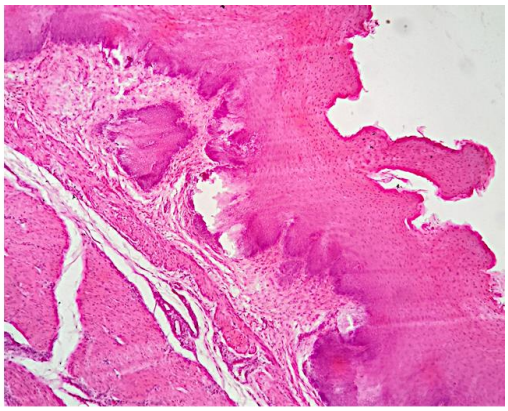

Figure 3: Histophotographic image showed normal histological architecture of crop from control chicks of G1. HE X20.

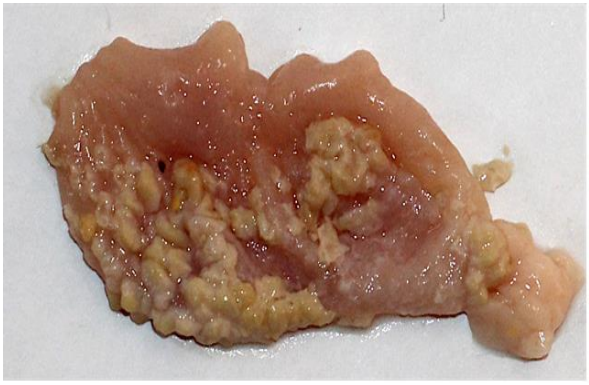

Figure 4: A photographic image showing the gross lesion in a crop from chicks of G3 that are infected with candida albicans .There is increased thickness of the wall of the crop and a typical yellowish pseudomembranous diphtheritic exudate.

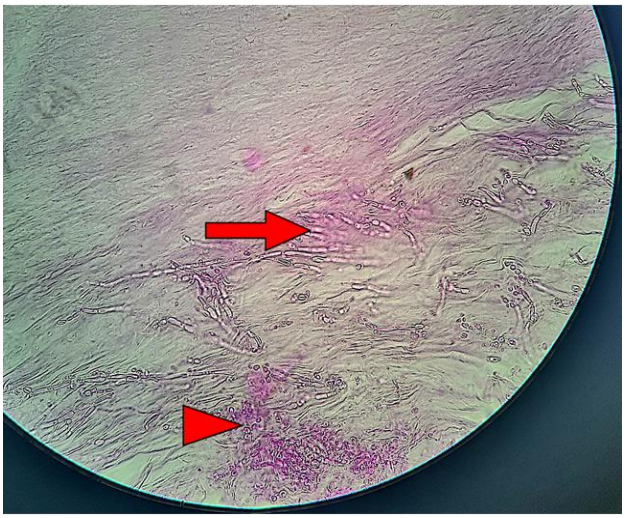

Figure 5: Histophotographic image of a crop from G3 showed fungal hyphae (arrow) and fungal spore (arrowhead) proliferated within squamous epithelia. PAS X40.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

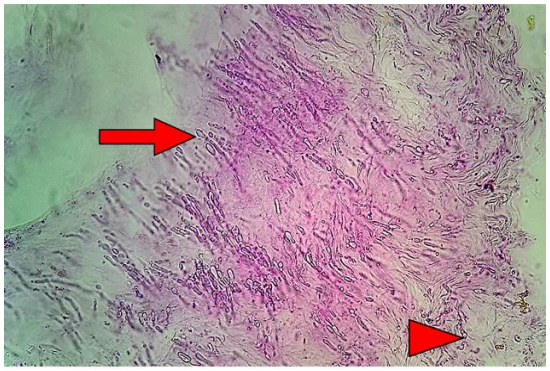

Figure 6: Histophotographic image of a crop from G3 showed fungal pseudohyphea (arrow) and spore proliferated within squamous epithelia and lamia propria (arrowhead). PAS X40.

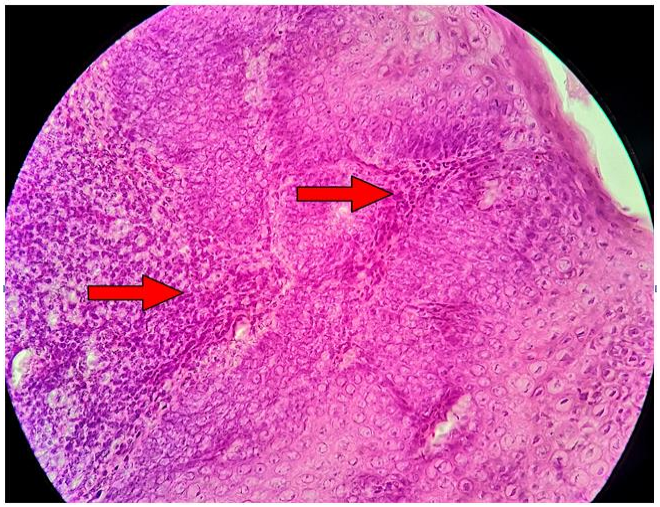

Figure 7: Histophotographic image of a crop from G3 showed sever inflammatory response within sub mucosa, Lamina properia and musclaris mucosa. HE X40.

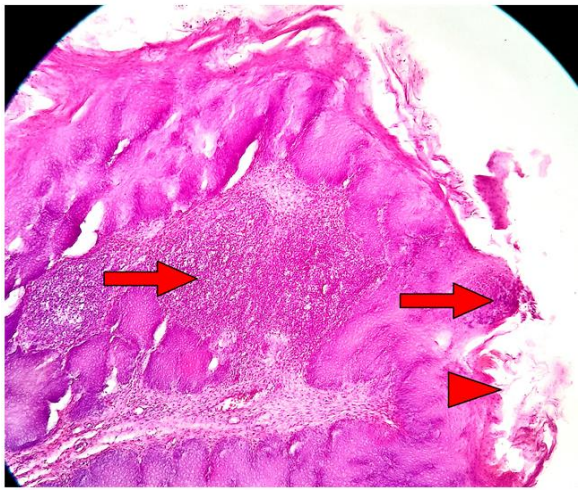

Figure 8: Histophotographic image of a crop from G3 . The epithelium is ulcerated and invaded by inflammatory cells (arrows). On the margins of the ulcer there is intercellular edema, dissociation, necrosis, and exfoliation of keratinocytes (arrowhead). HE X20.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

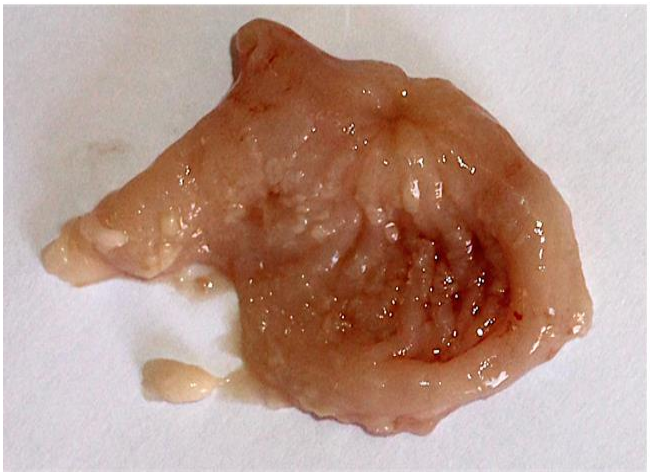

Figure 9: A photographic image showing the gross lesion in a crop from chicks of G4 that are infected with candida albicans and treated with Saccharomyces Cerevisiae. There is increased thickness of the wall of the crop with less lesion when compared to G3.

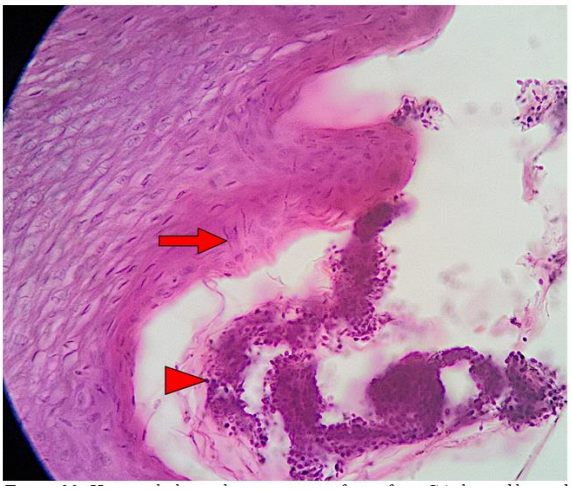

Figure 10: Histopathological examination of crop from G4 showed limited fungal infestation of squamous layer (arrow) and heavy spore accumulation within crop lumen (arrowhead). HE X40.

Conclusions and recommendations

This study the first experiment examining the effect of Saccharomyces Cerevisiae on avian candidiasis. This treatment was found effective in controlling crop candidiasis in birds. This method is inexpensive, has no reported side effects and can have positive effective on growth performance and FCR. We recommended adopting this treatment in clinical field as prophylactic measure to prevent candidiasis in commercial poultry. More research studies are needed to examine the effects of Saccharomyces Cerevisiae on other enteric infections.

References

[1]. Ahmed, M. E., T. E. Abbas, M. A. Abdlhag, and D. E. Mukhtar. Effect of dietary yeast (Saccharomyces cerevisiae) supplementation on performance, carcass characteristics and some metabolic responses of broilers. Anim. Vet. Sci 3: 5–10. 2015.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

[2]. Arné, P., and M. D. Lee. Fungal Infections. In: Diseases of Poultry. John Wiley & Sons, Ltd. pp. 1109–1133. 2020.

[3]. Buba, W., T. S. Olugbemi, J. J. Omage, S. Duru, and A. O. Iyiola-Tunji. Performance of broiler chickens fed varying levels of baker's yeast (Saccharomyces cerevisiae) during the hot season in the northern guinea savannah of Nigeria. Journal of Animal Production Research 28: 215–226. 2016.

[4]. Buffie, C. G., V. Bucci, R. R. Stein, P. T. McKenney, L. Ling, A. Gobourne, D. No, H. Liu, M. Kinnebrew, and A. Viale. Precision microbiome reconstitution restores bile acid mediated resistance to Clostridium difficile. Nature 517: 205–208. 2015.

[5]. Chand, N., and R. U. Khan. Replacement of Soybean Meal with Yeast Single Cell Protein in Broiler Ration: The Effect on Performance Traits. Pakistan Journal of Zoology 46. 2014.

[6]. Dizaji, S. B., and R. Pirmohammadi. Effect of Saccharomyces cerevisiae and Bioplus 2B on performance of laying hens. International Journal of Agriculture and Biology 11: 495–497. 2009.

[7]. Dykstra, M. J., B. R. Charlton, R. P. Chin, and H. J. Barnes. Fungal Infections. In: Diseases of Poultry, 13th ed. John Wiley & Sons, Ltd. pp. 1075–1096. 2013.

[8]. L. N. Balai, G. K. J. A. K. S. (2022). Investigations on PAPR and SER Performance Analysis of OFDMA and SCFDMA under Different Channels. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(5), 28–35. https://doi.org/10.17762/ijrmee.v9i5.371

[9]. Elnagar, S. H. Effect of dried yeast (Saccharomyces cerevisiae) supplementation as feed additive to layer hens on egg production, egg quantity, carcass traits and blood constituents. Egyptian J. Anim. Prod 50: 111–115. 2013.

[10]. Ezema, C. The performance of broilers fed palm kernel cake-based diet supplemented with bioactive yeast. IVI. Sc thesis. Department of Animal Health and Production. University of Nigeria, Nsukka. 2007.

[11]. Ezema, C., and C. C. Ugwu. Probiotic effects of Saccharomyces cerevisiae on nutrient digestibility and pH of the gastrointestinal tract of broilers. In: Proceedings of the international conference on beneficial microbes ICOBM. pp. 27–29. 2014.

[12]. Ezema, M. C. Probiotic Effects of Saccharomyces cerevisiae on Laying Chicken Fed Palm Kernel Cake–Based Diets. PhD. 2012.

[13]. Falagas, M. E., G. I. Betsi, and S. Athanasiou. Probiotics for prevention of recurrent vulvovaginal candidiasis: a review. Journal of Antimicrobial Chemotherapy 58: 266–272. 2006.

[14]. Gabrielli, E., E. Pericolini, N. Ballet, E. Roselletti, S. Sabbatini, P. Mosci, A. C. Decherf, F. Pélerin, S. Perito, and P. Jüsten. Saccharomyces cerevisiae-based probiotic as novel anti-fungal and anti-inflammatory agent for therapy of vaginal candidiasis. Beneficial microbes 9: 219–230. 2018.

[15]. Hassanein, S. M., and N. K. Soliman. Effect of probiotic (Saccharomyces cerevisiae) adding to diets on intestinal microflora and performance of Hy-Line layers hens. J. Am. Sci 6: 159–169. 2010.

Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

[16]. Ibrahim, Z. Y., B. H. Ali, R. K. Ali, A. S. Jarad, W. H. Farhan, and M. S. Hasan. Avian Candidiasis: A Review. International Journal of Pharmaceutical Research 12: 4. 2020.

[17]. Liu, M., K. V. Clemons, M. E. Johansen, M. Martinez, V. Chen, and D. A. Stevens. Saccharomyces as a vaccine against systemic candidiasis. Immunological investigations 41: 847–855. 2012.

[18]. Chaudhary, D. S. . (2022). Analysis of Concept of Big Data Process, Strategies, Adoption and Implementation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 05–08. https://doi.org/10.17762/ijfrcsce.v8i1.2065

[19]. Luna, L. G. Manual of histologic staining methods of the Armed Forces Institute of Pathology. 1968.

[20]. MA, R., H. BF, K. MU, K. PI, and A. JO. Effect of different levels of supplemental yeast on performance indices and serum biochemistry of broiler chickens. In: The Open Conference Proceedings Journal. vol. 3. 2012.

[21]. Moretti, A., D. Piergili Fioretti, L. Boncio, P. Pasquali, and E. Del Rossi. Isolation of Candida rugosa from turkeys. J. Vet. Med. B Infect. Dis. Vet. Public Health 47: 433–439. 2000.

[22]. Najib, H. Effect of incorporating yeast culture Saccharomyces cerevisiae in to the Saudi Baladi and White leghorn layer's diet. Journal of Applied Animal Research 10: 181–186. 1996.

[23]. Nursoy, H., O. Kaplan, M. N. Oguz, and O. Yilmaz. Effects of varying levels of live yeast culture on yield and some parameters in laying hen diets. Indian veterinary journal 81: 59–62. 2004.

[24]. Ogbuewu, I. P., V. M. Okoro, E. F. Mbajiorgu, and C. A. Mbajiorgu. Yeast (Saccharomyces cerevisiae) and its effect on production indices of livestock and poultry—a review. Comp Clin Pathol 28: 669–677. 2019.

[25]. Onwurah, F. B., K. U. Amaefule, and F. O. Ahamefule. Effect of baker's yeast (Saccharomyces cerevisiae) inclusion in feed and in drinking water on performance of broiler birds. British Journal of Applied Science & Technology 4: 144. 2014.

[26]. Paryad, A., and M. Mahmoudi. Effect of different levels of supplemental yeast (Saccharomyces cerevisiae) on performance, blood constituents and carcass characteristics of broiler chicks. African Journal of Agricultural Research 3: 835–842. 2008.

[27]. Sharma, A. . (2022). On the Computation of Bijective Probability Spaces. International Journal on Recent Trends in Life Science and Mathematics, 9(1), 47–63. https://doi.org/10.17762/ijlsm.v9i1.141

[28]. Pericolini, E., E. Gabrielli, N. Ballet, S. Sabbatini, E. Roselletti, A. Cayzeele Decherf, F. Pélerin, E. Luciano, S. Perito, and P. Jüsten. Therapeutic activity of a Saccharomyces cerevisiae-based probiotic and inactivated whole yeast on vaginal candidiasis. Virulence 8: 74–90. 2017.

[29]. Pollock, C. Fungal diseases of columbiformes and anseriformes. Vet Clin North Am Exot Anim Pract 6: 351–361. 2003.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 23, No. 3 (2022)
http://www.veterinaria.org
Article Received: 10 April 2022; Revised: 05 May 2022; Accepted: 30 May 2022; Publication: 27 August 2022

[30]. Premanathan, M., F. A. A. Shakurfow, A. A. Ismail, M. A. Berfad, A. T. Ebrahim, and M. M. Awaj. Treatment of oral candidiasis (thrush) by Saccharomyces cerevisiae. Int J Med Med Sci 3: 83–6. 2011.

[31]. Quinn, P. J., B. K. Markey, F. C. Leonard, E. S. Fitzpatrick, and S. Fanning. Concise Review of Veterinary Microbiology. John Wiley & Sons. 2015.

[32]. Quinn, P. J., B. K. Markey, F. C. Leonard, P. Hartigan, S. Fanning, and E. S. Fitzpatrick. Veterinary Microbiology and Microbial Disease. John Wiley & Sons. 2011.

[33]. Reed, G., and T. W. Nagodawithana. Yeast technology. Van Nostrand Reinhold, New York. 1991.

[34]. Rippon, R. J., M. R. Alley, and I. Castro. Candida albicans infection in free-living populations of hihi (stitchbird; Notiomystis cincta). New Zealand Veterinary Journal 58: 299–306. 2010.

[35]. Inna Rakhmawati, Anak Agung Ayu Mirah Adi, Ida Bagus Oka Winaya, Palagan Senopati Sewoyo. (2022). In Vivo Oncolytic Potency of Newcastle Disease Virus Gianyar-1/AK/2014 Virulent Strain Against Mice Fibrosarcoma Models. Revista Electronica De Veterinaria, 56 - 63. Retrieved from https://www.veterinaria.org/index.php/REDVET/article/view/139

[36]. Sacakli, P., A. Ergun, B. H. Koksal, B. Ozsoy, and Z. Cantekin. Effects of inactivated brewer's yeast (Saccharomyces cereviciae) on egg production, serum antibody titres and cholesterol levels in laying hens. Vet Med Zoot 61: 53–60. 2013.

[37]. Shankar, P. A., K. Premavalli, A. V. Omprakash, J. J. Kirubakaran, G. H. Hudson, and S. Vairamuthu. Effect of Dietary Yeast Supplementation on Serum Biochemical Profile of Broiler Chicken.

[38]. Shareef, A. M., and A. S. A. Al-Dabbagh. Effect of probiotic (Saccharomyces cerevisiae) on performance of broiler chicks. Iraqi J Vet Sci 23: 23–29. 2009.

[39]. Swain, B. K., P. K. Naik, E. B. Chakurkar, and N. P. Singh. Effect of probiotic and yeast supplementation on performance, egg quality characteristics and economics of production in Vanaraja layers. Indian Journal of Poultry Science 46: 313–315. 2011.

[40]. Tsai, S. S., J. H. Park, K. Hirai, and C. Itakura. Aspergillosis and candidiasis in psittacine and passeriforme birds with particular reference to nasal lesions. Avian Pathol. 21: 699–709. 1992.

[41]. Velasco, M. C. Candidiasis and cryptococcosis in birds. Seminars in Avian and Exotic Pet Medicine 2: 75–81. 2000.

[42]. Wilson, D. A tale of two yeasts: Saccharomyces cerevisiae as a therapeutic against candidiasis. Virulence 8: 15–17. 2017.

[43]. Yalçın, S., S. Yalçın, K. Cakın, Ö. Eltan, and L. Dağaşan. Effects of dietary yeast autolysate (Saccharomyces cerevisiae) on performance, egg traits, egg cholesterol content, egg yolk fatty acid composition and humoral immune response of laying hens. Journal of the Science of Food and Agriculture 90: 1695–1701. 2010.

[44]. The Effects of Antibiotic Growth Promoter, Probiotic or Organic Acid Supplementation on Performance, Intestinal Microflora and Tissue of Broilers