Journal of Agricultural, Environmental and Veterinary Sciences
Volume (4), Issue (3): 30 Sep 2020
P: 86 - 96

ISSN: 2522-3364

مجلة العلوم الزراعية والبيئية والبيطرية
المجلد (4)، العدد (3): 30 سبتمبر 2020م
ص: 86 - 96

Study treating infected pigeons with Newcastle virus and effects on the mortality rate

Huda Ghanim Dakhil

Mariam Mustafa Abbas

Gifted school || Missan || Iraq

Abstract: Newcastle virus is a dangerous infectious virus that causes economic losses in birds such as pigeons, chickens and others. The current study was aimed to treat Newcastle disease in pigeons and record effects of it on treated pigeon embryos for several generations.

Extracted the clotted blood from the neck of infected birds by a sterile needle, supplying their diet with the garlic and orange juice, and feeding them by-hand for 1-2 weeks.

The current study recorded the recovery of all treated birds under the study. They were exhibiting less twisting of the head, back to eat by themselves, and the eggs were laid after 8-10 weeks after treatment. It was observed that only female pigeons infected with virus during the study period from September 2019 to April 2020. The treated pigeons laid several generations. The mortality was 50%, 100%, 100%, and 50% for the first, second, third, and fourth-generation respectively. It was observed some behavioral changes in 2 of chicks from the healthy chick pigeons of the first generation, while in the fourth generation, was noticed that 5 of chicks were infected immediately after hatching and they died at an age of 5-7 days.

The current study concluded that removing the clot with diet played effective role in treating infected pigeons, also the Newcastle disease caused a mortality of 75% in embryos of treated pigeons.

This study recommends to great caution when removing the blood clot, the infected chicks must be isolated.

Keywords: Newcastle virus, pigeons, garlic.

دراسة علاج الحمام المصاب بفيروس التواء العنق وتأثيراته على معدل الوفيات

هدى غانم داخل

مريم مصطفى عباس

مدرسة الموهوبين || ميسان || العراق

الملخص: يُعد فيروس نيوكاسل من الفيروسات المعدية الخطيرة التي تسبب خسائر اقتصادية عالية في الطيور مثل الحمام والدجاج وغيرها. هدفت الدراسة الحالية إلى علاج مرض التواء العنق وتسجيل تأثيراته المرضية على أجنة الحمام المعالج ولعدة أجيال.

استخرج الدم المتخثر من رقاب الطيور المصابة باستخدام إبرة معقمة، ودعم نظامهم الغذائي بالثوم وعصير البرتقال وإطعامهم يدويا لمدة تتراوح بين 1-2 أسبوع.

سجلت الدراسة الحالية شفاء جميع الطيور المعاملة قيد الدراسة، إذ قلّ التواء العنق وعادت قدرتهم على الأكل بأنفسهم وتم وضع البيض بعد 8-10 أسابيع بعد العلاج. لوحظ في الدراسة الحالية إصابة إناث الحمام فقط بالفيروس خلال فترة الدراسة التي امتدت من أيلول2019 إلى نيسان 2020، وقد وضعت الطيور المعالجة عدة أجيال، وكانت نسبة الوفيات في الأجنة 50%، 100%، 100%، و50%

للجيل الأول والثاني والثالث والرابع على التوالي. لوحظت بعض التغييرات السلوكية على 2 من الأفراخ الحية للجيل الأول، إما بالنسبة إلى الجيل الرابع فقد لوحظ إصابة 5 منهم بعد الفقس مباشرة وماتوا بعمر 5-7 أيام إما البقية كانت طبيعية المظهر.
استنتجت الدراسة الحالية أن إزالة الخثرة مع الحمية الغذائية لعبت دورا فعالا في معالجة الحمام المصاب، كذلك سَبب مرض التواء العنق وفيات 75% في أجنة الحمام المعالج. واستنادا للنتائج أوصت الدراسة بالحذر الشديد عند إزالة الخثرة كما يجب عزل الأفراخ المصابة.

الكلمات المفتاحية: مرض النيوكاسل، الحمام، الثوم.

Introduction

Newcastle disease is a contagious viral disease that can infect many birds species from the domestic to the wild species (Al-Shammari et al., 2014), It has been included in list A of the Office International des Epizooties OIE (Alexander, 1997) among the greatest importance infectious diseases (Lind et al., 2010). It is caused by virulent strains of single-stranded, non-segmented, negative-sense RNA virus called avian paramyxovirus-1 (APMV-1) (Ashraf and Shah, 2014) that has been classified in the genus Avulavirus (Lamb et al., 2000). It was recognized for the first time in chickens in 1926, and later in geese, ducks, and pigeons (Seal et al., 2005). The infections with this virus had been established in at least 241 species of birds representing 27 of the 50 orders of the class Aves (Kaleta and Baldauf, 1988).

Newcastle disease is an economically important disease, and also a major threat to the poultry industry (Narayanan et al., 2010) since it first appeared in the world in Java island, Indonesia in 1926 (Alexander and Senne, 2008). It causes annual losses worldwide millions of dollars (Susta et al., 2011; Waheel et al., 2013) and has its greatest impact on villages where people's livelihood depends upon domestic animals (Mohamed et al., 2011; Rezaeianzadeh et al., 2011). Newcastle disease virulence has been classified into three strains: lentogenic, mesogenic and velogenic that produce the mild-moderate and highly acute form of infection in domestic birds, respectively (Alexander and Senne, 2008), but only velogenic strain causes disease in pigeons (Saif, 2008). The clinical signs of Newcastle disease are dependent on some factors such as the virus strain, host species, age of the host, co-infection with other microorganisms, environmental stress, and immune system of birds (Al-Habeeb et al., 2013).

The incubation period ranges from 2 to 15 days. (Pansota et al., 2013). Signs of Newcastle disease differ in intensity and lethality, but usually include difficulty in breathing, diarrhea, circulatory troubles, damage in the central nervous system, shivering with paralysis of wings and legs has been observed in pigeons (Alexander, 1997; Shaheen et al., 2005). Morbidity and mortality averages 100 and 80%, respectively (Eisa and Omer, 1984) with a decrease in egg production (Choi et al., 2010).

Newcastle disease can be transmitted to humans, it was reported as a zoonotic disease for the first time by Burnet, in 1943 (Pedersden et al., 1990). Transmission occurs through exposure to fecal and respiratory aerosols and other excretions from infected birds. Controls on this disease get rid of sick birds and contaminated feed, water, equipment and clothing (Desalegn, 2015). It may cause conjunctivitis in humans when a person has been exposed to large amounts of the virus (Alexander, 2000).

Vaccination is the most essential to prevent of Newcastle disease, Non-usage of Newcastle disease vaccine in rural regions is one of the important factors for Newcastle disease outbreak (Mustafa and Ali, 2005). Currently, many of vaccines are available around of the world (Xiao et al., 2013), vaccines are being developed include the subunit and recombinant vaccines and DNA vaccines (Peeters et al., 2000).

In Iraq, no research about the treatment the birds by pulling the clotted blood in the neck of the infected birds and feeding, also no research detection the effect of Newcastle disease on embryos of treated pigeons, therefore the current study was aimed to suggestion effective treatment method and record effects of the Newcastle disease on treated pigeon embryos for several generation.

Materials and Methods

1- Collecting of the samples

15 pairs of pigeons at age more than 5 month, were brought from the local markets in Missan, southern of Iraq, at the beginning of September 2019. 5 pairs were the control not infected by Newcastle disease that instated in cages in an area far from the infected pigeons' under the study and they were fed by different grains, while the other 10 pairs of pigeons were infected one of the two pigeons of each pair by Newcastle disease, when examination sex of pigeons depended on behavior, the pelvic bones, neck and head shape, it became clear that all affected pigeons were females (Fig. 1).

2- Treatment of infected pigeon

1- Some feathers were removed from different regions in the birds' body such as the neck and long feathers only from the wings, and the tail (Fig. 2).
2- By using a sterilized needle, we were made several small wounds at the coagulate site under the neck skin to remove the clotted blood (coagulate site appears as a dark black color under the skin) (Fig. 3).
3- Infected birds had been given some specific food to their diet. We have used the fresh garlic (1Gram of garlic /day, divided into 3 meals) and fresh orange juice (5ml /day, divided into 3 meals) for each infected pigeon in addition to different grains, and feed them by-hand for 1-2 weeks.

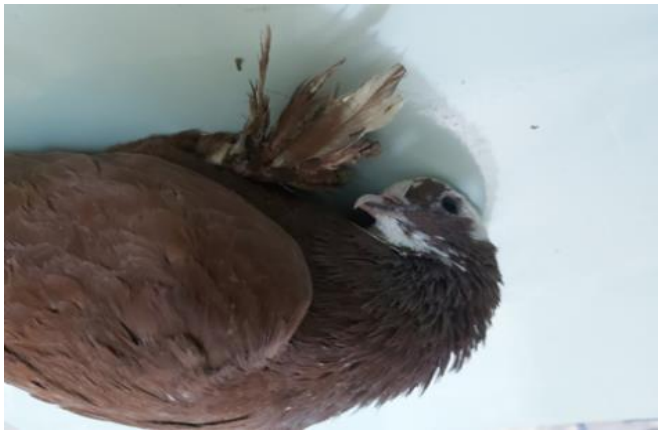

Fig. (1) Newcastle disease infected pigeon.

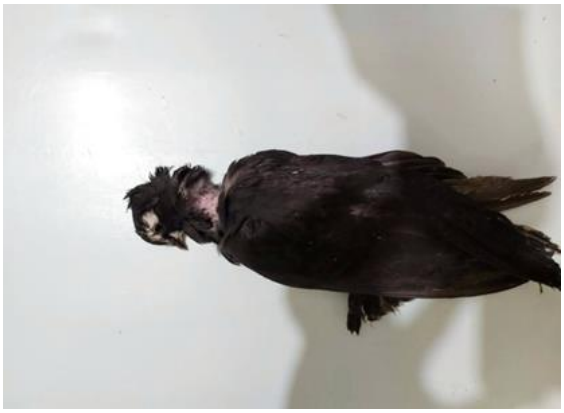

Fig. (2) Remove the feathers from the neck.

Fig. (3) Clotting blood under the neck skin of the infected pigeon.

← Indicate to clotting under the neck skin.

Results and Discussion

Newcastle disease is a worldwide important disease of birds that doesn't threaten the poultry industry only, but all the existing birds' species and the whole biodiversity, and can lead to huge outbreaks in the world with great economic losses. Making a treatment for this disease is the aim of the scientific world. The current study developed an effective method for treating it in birds, using easy and daily-available materials for human use.

Some feathers were removed from various parts in the bird's body, to see location of the coagulate was under the neck skin and around the ears of infected birds (Abbas et al., 1992). Also, to promote the nourishment of the circulatory system of birds and help removing microbes as well as help producing new healthy feathers (Gill, 2007). In addition to their ordinary diet by addition the garlic and orange juice, garlic inclusion in birds' diet helped to upgrade the immune performance against Newcastle disease (Ahsan et al., 1999). It contains natural antioxidants (Saravanan and Prakash, 2004) and has blood anti-coagulation properties that helped the birds to dispose the remained clotted blood in their neck that has caused head tilt (Al-Qattan et al., 2006).

Oranges, which are citrus fruits, are rich sources of vitamin A, C, E, and other compounds (Zhou, 2012). These vitamins as antioxidant activity (Zhang et al., 2015). Vitamin C is a natural free radical scavenger, which can effectively scavenge a variety species of reactive oxygen species and release semi dehydroascorbic acid that clearing 1O2 and reducing sulfur radicals (Amitava and Kimmberly, 2014), vitamin C necessary to blood formation (Taylor and Cohen, 2012), therefore oranges were used to help the pigeons under treated to recover and to produce new and fresh blood with new white blood cells to defense against the microorganisms.

The current study was recorded healed all the infected mother pigeons with Newcastle disease at a period between 1-2 weeks after removed the clotted blood under the neck skin with diet. They started moving their head, eating alone without any help. After the infected pigeons got healed, they regained their ability to lay eggs at 8-10 weeks after treatment, and continued until the end of the study at the end of April. This results disagrees with (Waihenya et al., 2002) who confirmed that no research have documented the time needed to treat Newcastle disease in birds when used a plant called Aloe secundiflora to treat Newcastle disease in birds, Furthermore they found that the use of this plant can reduce the mortality of the infected birds to 21.6%-31.6%. It also disagrees with (Lans et at., 2007) who used a plant called Euphorbia ingens to treat it in chickens and they concluded that this plant can decrease the mortality by 38.4%. also used some plants to treat Newcastle disease in birds, They used garlic aqueous extract to treat it in birds, It suggested that the aqueous extracts of garlic enhanced the immune response to live Newcastle disease vaccine (Bulus and Zaro, 2019), the garlic used in-vitro as an antimicrobial against many human pathogens (Lee et al., 2008), garlic use also in pharmacology (Khan et al., 2012). Sule et al., 2018 carried out a work to investigate the effectiveness of aqueous garlic extract against Newcastle diseases virus in birds. This study concluded that the birds treated with aqueous garlic extract boosts the immune system. All these researches reported that the use of plants, especially garlic, against Newcastle disease has a positive effect and raise the immunity of birds to fight the existing virus.

Both males, and females can be infected with Newcastle disease, but in the current study recorded infection in female only, which agreed with (Munmum et al., 2016) who found that female pigeons are more affected by Newcastle disease than male pigeons 50.6%, and 45.2%, respectively. While

it disagreed with a study done in 1973 (Kutubuddin, 1973) who indicated that male birds are more affected than females. The actual cause of this apparent sex- related difference in the carriage of the Newcastle disease virus is still not understood.

The current study mortality in embryos from infections birds mother were 50% mortality of the first generation of embryos (Table1), and it was observed two of chicks (when it became 3 months) were suffering some behavioral changes that haven't been seen in the pigeons' chicks under the control, it were feral, they were eat other chicks, this cause can be a return to effects of Newcastle virus on some brain cells. Such behavioural changes resulted from infection with a foreign organism have been reported, like permanent ones caused by toxoplasmosis infection in animals such as mammals (including cats, and humans, etc.) (Tenter et al., 2000).

In the next two generations, the mortality was 100% in both, the embryos died after completion in eggs, and they didn't hatch until they rotted inside their eggs (Fig. 4). In the fourth generation of eggs that have a mortality of 50%, the current study was noticed 5 of them infected immediately after hatching and they were died at the age of 5-7 days, while not recorded any infections in embryos with Newcastle disease in control pigeons, it might be transferred genetically to DNA of ova from the mother bird, Newcastle disease have been reported the reproductive systems in the birds (Miller and Koch, 2013). Newcastle virus can replicate in the reproductive tract of hens and contaminate internal components of eggs and eggshell surface, but vaccination was able to prevent internal egg contamination (Silva et al., 2015). Viral replication in the reproductive tract has resulted in the appearance of some Newcastle disease clinical signs, such as the production of deformed eggs, rough-shelled eggs, the decline in the number of produced eggs, or decreased albumin quality (Yan et al., 2011). However, microbes including viruses, can't pass through the microscopic pores into the eggs, so the virus won't come from the external environment into the egg, Newcastle disease virus still might be existed in the ovaries of the treated mother bird, but with no signs of infection, and transferred from the reproductive tract to the yolk and albumin of eggs, the infection of the ovarian follicles, and the magnum with Newcastle disease can be related with the occurrence of the virus in the yolk, and albumin (Gill, 2007 ; Bwala et al., 2011).

At the end, the current study found that the mortality of pigeons' embryos was 75%, which disagreed with (Al-Shammari et al., 2014) who found that the mortality of birds' embryos was 100% and (Qosimah et al., 2018) who also indicated that the mortality was 100%. It is reported for the first time that the mortality of birds' embryos, that were laid by treated birds was infected by Newcastle disease, was 75% and not 100% and can be decrease mortality for more generations of treated pigeons, after many generations they are able to produce alive and healthy chicks, this means that there is some progress in finding a useful medicine against Newcastle disease, which can help birds, and also people who are depending on poultry for their income, and food uptake all over the world.

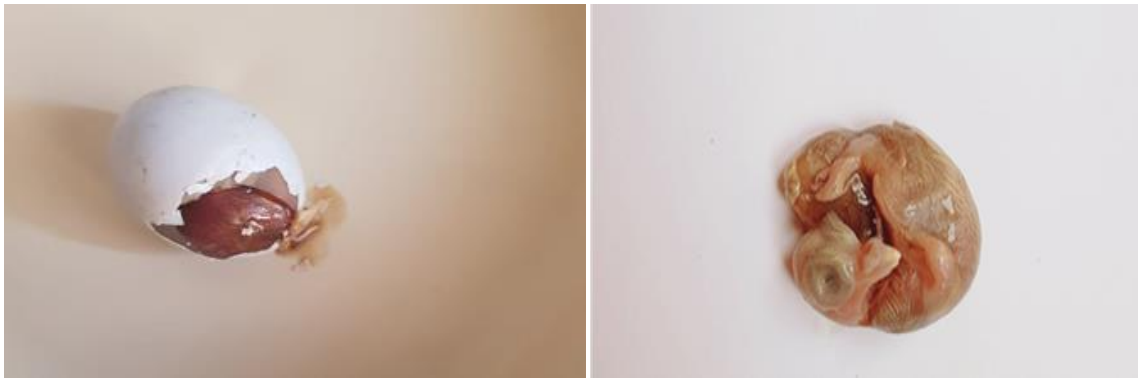

Fig. (4) The embryos died after completion in eggs.

Table (1) The mortality ratio of generation treated pigeon

Generation	Total number of eggs	Total number of died embryos	Mortality%
First	20	10	50%
Second	20	20	100%
Third	20	20	100%
Fourth	20	10	50%
Total	80	60	75%

Conclusions

1- Removing the clot from infected pigeons, and feeding them with garlic and orange juice in their diet played a very effective role in their recovery from this lethal disease.

2- Newcastle disease affected many generations of pigeons' embryos and had caused a mortality of 75% of embryos, but with more generations can be decreased the rate of mortality.

Recommendations

1- Great caution when removing the coagulate by correctly determining the location of the coagulation and preventing bleeding.

2- Must be isolate infected chicks from non-infected to preventing spreading the virus among the pigeons.

References

- Abbas, G., Haq, A.U., Shakoor, A.(1992). "Haematology and serum electrolyte patterns during Newcastle disease in layer chicks". Pak J Agri Sci. 29(2):134-136.
- Ahsan, U.H., Meraj, K.A., Rasool, S.(1999). "Effect of Supplementing Allium Sativum (Garlic) and AzadirechtaIndica (Neem) Leaves in Broilers Feed on their Blood Cholesterol, Triglycerides and Antibody Titer".Int J AgriBiol.1(3), 125-127.

- Alexander, D.J.(1997). Newcastle disease and Avian paramyxovirus infections.10thEd. In:Calnek BW, Bernes HJ, Beard CW, McDougald LR, Saif YM (editors), Disease of Poultry, Iowa State University Press, Ames, USA. 541-569.
- Alexander, D.J.(2000). " Newcastle disease and other avian paramyxoviruses". Rev Sci Tech Off IntEpiz. 19(2):443- 462.
- Alexander, D.J., Senne, D.A.(2008).Newcastle disease, other avian paramyxoviruses, and pneumovirus infections. 12thEd. In: Saif, Y. M., Fadly, A. M.and Glisson, J. R. et al. (eds) Diseases of Poultry. Ames: Iowa State University Press.75—116.
- Al-Habeeb, M.A., Mohamed, M.H.A., Sharawi, S. (2013). " Detection and characterization of Newcastle disease virus in clinical samples using real time RT-PCR and melting curve analysis based on matrix and fusion genes amplification". Vet World. 6(5):239-243.
- Al-Qattan, K.K., Thomson, M., Al-Mutawa'a, S., et al.(2006). " Nitric oxide mediates the blood-pressure lowering effect of garlic in the rat two-kidney, one-clip model of hypertension". J Nutr. 136(3):774S–776S.
- Al-Shammari, A.M., Al-Nassrawei. H.A., Murtadha, A.M.H.(2014)."Molecular diagnosis of Newcastle disease Iraqi Virulent strain virus HN gene by specific primers design". Kufa J Vet Med Sci. 5(2):196-203.
- Amitava, D., Kimberly, K.(2014). Antioxidants in Food, Vitamins and Supplements. 1st ed., Elsevier, pp.360.
- Ashraf A, Shah MS. Newcastle Disease: Present status and future challenges fordeveloping countries. AfricanJ Microbiol Res. 2014; 8(5):411-416.
- Bulus, E., and Zaro, H.J.(2019)."Effect of garlic on immunological response of broiler and FUNAAB-ALPHA breed of chicken in comparison to Newcastle disease vaccine (lasota)". Int JAgriBiosci. 8(4):170-173.
- Bwala, D.G., Clift, S., Duncan, N.M., Bisschop, S.P., Oludayo, F.F. (2011) "Determination of the distribution of lentogenic vaccine and virulent Newcastle disease virus antigen in the oviduct of SPF and commercial hen using immunohistochemistry". Revue Scientifiqueet Technique. 93(1): 520–528.
- Choi, K.S., Lee, E.K., Jeon, W.J., Kwon, J.H. (2010)."Antigenic and immunogenic investigation of the virulence motif of the Newcastle disease virus fusion protein". J Vet Sci.11(3):205-211.
- Desalegn, J.M. (2015). Epidemiology of Village Chicken Diseases: A Longitudinal Study on The Magnitude and Determinants of Morbidity and Mortality- The Case of Newcastle and Infectious Bursal Disease. MSc Thesis, Addis Ababa University, Ethiopia.
- Eisa, M., Omer, E.A. (1984)."A natural outbreak of Newcastle disease in pigeons in Sudan". Vet Rec. 114(12): 297.

- Gill, F.B.(2007).Ornithology. 3rd ed. W. H. Freeman & Company, New York. 1-758p.
- Kaleta, E.F., Baldauf, C. (1988). Newcastle disease in free-living and pet birds. 1ed. In: Alexander, D.J. (edn).NewcastleDisease, Kluwer Academic Publishers, Boston. 8:197-246.
- Khan, S., Sultan, A., Chand, N., Mushtag, M., Rafiullah, and Qureshi, M.S. (2012)."Garlic (Allium sativum) modulated serum cholesterol level and improved immune status and carcass quality of meat type bird".proceeding of the 15th AAA Panimal science congress. 1042-1046.
- Kutubuddin, K. (1973). "Pathological investigation on the causes of mortality of chickens in the BAU poultry farm".M.Sc. Thesis. Department of Pathology. Faculty of Veterinary Science Bangladesh Agricultural University, Mymensingh, Bangladesh.
- Lamb, R.A., Collins, P.L., Kolakofsky, D., Melero, Y., Nagai, Y., Oldstone, M.B.A., Pringle, C.R., Rima, B.K. (2000)."Family Paramyxoviridae. In M.V.H. van Regenmortel (Ed.), Virus Taxonomy, Seventh report of the International Committee on Taxonomy of Viruses". Academic Press, New York. 549-561p.
- Lans, C., Khan, T.E., Curran, M.M., McCorkle, C.M. (2007)."Ethno veterinary medicine: potential solution for large scale problems ". Veterinary Herbal Medicine, pp. 17-32.
- Lee, S.Y., Shin, Y.W. and Hahm, K.B.(2008). " Phytoceuticals: Mighty but ignored Weapons against Helicobater pylori infection". J Dig Dis. 9:129-139.
- Linde, A.M., Munir, M., Zohari, S., Stahl, K., Baule, C., Renstrom, L., Berg, M.(2010)."Complete genome characterization of a Newcastle disease virus isolated during an outbreak in Sweden in 1997". Virus Genes. 41(2):165-173.
- Miller, P.J., Koch, G.(2013).Newcastle disease. 13th.In: Swayne, DE, Glisson, JR, McDougald LR, Nolan LK, Suarez DL and Nair V (Eds), Diseases of Poultry. ed., Wiley-Blackwell, 89—138.
- Mohamed, H.A., Kumar, S., Paldurai, A., Samal, S.K.(2011). "Sequence analysis of fusion protein gene of Newcastle disease virus isolated from outbreaks in Egypt during 2006".VirolJ. 8(1): 1-4.
- Munmun, T., Islam, K.M.F., Jalal, S., Das, T., Tofazzol, R., et al. (2016). "Investigation of Proportionate Prevalence of Newcastle Disease in Chicken, Pigeon and Duck at Selected Veterinary Hospitals in Bangladesh and India". J Dairy Vet Anim Res. 4(2): 00118.
- Mustafa, M.Y., Ali, S.S.(2005). "Prevalence of infectious diseases in local and fayoumi breeds of rural poultry (gallusdomesticus)". Punjab Univ J Zool. 20:177-180.
- Narayanan, M.S., Parthiban, M., Sathiya, P., Kumanan, K. (2010). "Molecular detection of Newcastle disease virus using Flinders Technology Associates-PCR ". J Veterinarski Arch. 80(1): 51-60.
- Nelson, C.B., Pomeroy, B.S., Schrall, K., Park, W.E., Lindeman, R.J. (1952). "An outbreak of conjunctivitis due to Newcastle disease virus (NDV) occurring in poultry workers". Am J Public Health Nations Health. 42(6):672-678.

- Pansota FM, Rizvi F, Sharif A, Javed MT, Muhammad G, Khan A, Khan MZ.(2013)."Use of hyperimmune serum for passive immunization of chicks experimentally infected with Newcastle disease virus". Pak J Agri Sci. 50(2):279-288.
- Pedersden, K.A., Sadasiv, E.C., Chang, P.W., Yates, V.J. (1990). "Detection of antibody to avian viruses in human populations". EpidemiolInfect.104(3):519-525.
- Peeters, B.P., Gruijthuijsen, Y.K., de Leeuw, O.S.(2000). "Gielkens AL Genome replication of Newcastle disease virus: involvement of the rule-of-six". Arch Virol. 145(9): 1829–1845.
- Qosimah, D., Murwani, S., Sudjarwo, E., Lesmana, M.A. (2018). "Effect of Newcastle disease virus level of infection on embryonic length, embryonic death, and protein profile changes".Vet World.11(9): 1316-1320.
- Rezaeianzadeh, G., Dadras, H., Safar, A., Ali, M., Nazemshirazi, M.H. (2011)."Serological and molecular study of Newcastle disease virus circulating in village chickens of Fars province, Iran". J Vet MedAnim Health. 3(8):105-111.
- Saif, Y.M. (2004).Diseases of Poultry. 12thed. Iowa State Univ. Press, Iowa, USA 2008;1352 p.
- Saravanan G, Prakash J.(2004)."Effect of garlic (Allium sativum) on lipid peroxidation in experimental myocardial infarction in rats". J Ethno pharmacol. 94(1):155–158.
- Seal, B.S., Wise, M.C., Pedersen, J.C., Senne, D.A., Alvarez, R., et al.(2005). "Genomic sequences of low-virulence avian paramyxovirus-1 (Newcastle disease virus) isolates obtained from live-bird markets in North America not related to commonly utilized commercial vaccine strains". Vet Microbiol., 106 (1-2):7-16..
- Shaheen, S., Anjum, A.D., Rizvi, F.(2005). "ClinicoPathological observations of Pigeons (Columba livia) suffering from Newcastle disease". Pak VetJ., 25(1):5-8.
- Silva, M.S., Susta, L., Moresco, K., Swayne, D.E.(2015)."Vaccination of chickens decreased Newcastle disease virus contamination in eggs". Avian Pathol., 45(1):1-29.
- Sule, A., Saleh, G., Isaac, S. (2018). "The Use of Garlic (Allium Sativum) Extracts as Replacement for Newcastle Disease [Lasota] Vaccine in Broiler Chicken". Am Res J Agri., 4(1): 1-6.
- Susta, L., Miller, P.J., Afonso, C.L., Brown, C.C. (2011). "Clinicopathological Characterization in Poultry of Three Strains of Newcastle Disease Virus Isolated From Recent Outbreaks". Vet Pathol., 48(2):349-360.
- Taylor, J.J., Cohen, B.J.(2012).Memmler'sStructure and function of the human body. 10thed. puplisher by Lippincott Williame and Wilkins. 1-538.
- Tenter, A.M., Heckeroth, A.R., Weiss, L.M. (2000). "Toxoplasma gondii: from animals to humans". Int JParasitol., 30(12-13):1217–1258.

- Waheed, U., Siddique, M., Arshad, M., Ali, M., Saeed, A. (2013). "Preparation of Newcastle disease vaccine from VG/GA strain and its evaluation in commercial broiler chicks". Pak J Zool., 45(2):339-344.
- Waihenya, R.K., Mtambo, M.M., Nkwengulila, G.J.(2002). "Evolution of the efficacy of the crude extract of Aloe secundiflorain chickens experimentally infected with Newcastle disease virus".J Ethnopharmacol.79(3): 299-304.
- Xiao, S., Paldurai, A., Nayak, B., Mirande, A., Collins, P.L., Samal, S.K. (2013). "Complete genome sequence of a highly virulent Newcastle disease virus currently circulating in Mexico". J Genome Announcements.1(1):01-02.
- Yan, Z., Du, Y., Zhao, Q., Fan, R., Guo, W., Ma, R., Wang, X., Zhu, R. (2011). "Mucosal immune responses against live Newcastle disease vaccine in immunosuppressed chickens". Pak Vet J. 31, 280-286.
- Zhang, H., Xi, W., Yang, Y., Zhou, X., Liu, X., Yin, S., et al.(2015). "An on-line HPLCFRSD system for rapid evaluation of the total antioxidant capacity of Citrus fruits". Food Chemistry, 172: 622–629.
- Zhou, Z.Q.(2012).Citrus fruits nutrition. Beijing, China: Science Press.