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Review Article

CHICKEN ANEMIA VIRUS AN ECONOMICALLY IMPORTANT POULTRY VIRUS

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ABSTRACT

Vamana (emetic therapy) is one among the panchakarma chikitsa (five eliminative therapies), where the morbid doshas are expelled through the oral cavity. Many vamaka yogas(emetics) have been mentioned in bruhatrayees (treatises of Ayurveda) in various forms of preparations. Madana phala (emetic nut) is considered as best vamaka dravya (emetic drug). The multi-dimensional activities of Randia dumetorum have been revalidated in recent times on several experimental models and even in well designed clinical trials. Various parts of this medicinal thorny shrub reveals Antibacterial, Anti-Allergic, Antiinflammatory, Analgesic, Immunomodulatory, therapeutic emetic and also used to check wound healing etc Shows us multiple precision of the plantThis review is an attempt to explore various yogas for vamana karma where madanaphala is used as the main ingredient.

INTRODUCTION

World's population has experienced continuous growth. The increased world population is estimated as 7.6 billion in the year 2018. However, the raise brings with it a number of challenges around global sustainability, including the need for more food. Poultry products considered as one of the most important source of cheapest food to fulfill the food needs of increased population, where the white meat (poultry meat) is very cheap as compared with the red meat (cow meat).Based on FAO statistics, suggest that chicken meat production increased by 2.3 and 4.0 percent per year respectively in developed and developing countries between 2006-2016.[1] India is the second most populated country next to China having 1.23 billion people and the number is growing every year. The focus is on development meaning good food, better health and living conditions to everyone. Healthy food at attractive price will be the issue in focus, so to fulfill the needs of increased population, there is also need of increased food production. Poultry is one of the fastest growing segments of the agricultural sector in India today. While the production of agricultural crops has been rising at a rate of 1.5 to 2 per cent per annum that of eggs and broilers has been rising at a rate of 8 to 10 percent per annum.[2] As a result, India is now the world's third largest egg producer and the ninth largest producer of broiler. Table eggs and broiler meat are the major end products of poultry sector in India.

Many pathogens include bacteria, fungus, protozoans and viruses those causes severe diseases in poultry flocks can leads to the drastic decrease in egg and meat production having direct effect on Indian economy. Among all diseases viral diseases cause serious threats to poultry industry. Virus that infect immune system are more dangerous than other infection. They cause destruction of immune cells and leads to immunosuppression. Immunosuppression always associated with secondary opportunistic infections. The immunosuppressive viral diseases directly affect the immune cells or immune organs and cause the destruction of immune cells, it further leads to immunosuppression. The immunosuppressed birds were susceptible to many other diseases like bacterial, fungal and protozoan diseases. Immunosuppression is always associated with secondary opportunistic infections, so it is very difficult to treat immunosuppressive diseases.[3]

Some immunosuppressive viral diseases and their target immune cells or organs were listed in table 1.

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Table 1 Viral diseases of poultry that effect immune organs and cells

Virus	Effect on immune organ or cell			
	B l B lymphocytes	T lymphocytes	Macrophages	Others
Gumboro disease	Depletion of bursa and peripheral population			
Marek's disease	Destruction in early stages of multiplication	TransftRANTTransformation in tumoral cells tumoralcelllllxmjuxgsixnbkjsguxy tumoral cells tumor		
Chicken infectious anaemia	Depletion of all cell lines			
Newcastle disease and Avian Influenza			Decrease in phagocytic activity	Damage in the trachea and cilia
Reovirus	Destruction by virus multiplication			

Source:https://en.engormix.com/poultry-industry/articles/immunosuppression poultryt34885.htm.

These immunosuppressive viral diseases has high economic importance due to their high morbidity and mortality rates and cause economic losses to poultry industry. Chicken Anaemia Virus (CAV) was more important because it has the ability to infect young birds by both vertical and horizontal mode of transmission. CAV was first reported in Japan in 1979. Later the virus isolates were circulating in all major chicken producing countries with worldwide distribution were characterized.. CAV causes disease called Chicken Infectious Anaemia (CIA) characterized by generalized lymphoid atrophy, increased mortality and severe anaemia. CAV replicates in lymphocytes and cause destruction of thymic lymphocytes is directly cytotoxic to bone marrow haematopoietic precursors leading to transient anaemia and immunosuppression. In India CAV was first isolated by Venugopalan *et al*., in 19944 and Kataria *et al*., in 19995confirmed the virus by PCR.

History

Chicken anaemia virus is also known as Chicken anaemia agent was first reported by Yuasa *et al*., 1979 in Japan.6 Later it was isolated from all major chicken producing countries, China (Zohu*et al*., 1997),7 United states of America (McNulty *et al*., 1989),8 United Kingdom (Chetle*et al*., 1989),9 Australia (Firth and Imai, 1990),10 France (Drouin*et al*., 1992),11 South Africa (Weiht and Maharaj, 1993),12 Sweden (Engstrom, 1988).13 In India it was first isolated by Venugopalan*et al*., in 1994 and it is PCR confirmed by Katria*et al*., in 1999. The International Committee for the Taxonomy of Viruses placed this CAV in family Circoviridae.

Economic Impact of Cav on Poultry Industry

Chicken anaemia virus was infecting broiler flocks causes severe economic loses to poultry industry by reducing the weight and poor quality of meat. In layers the infection is usually sub-clinical. In vertical infection the flock receives chickenanaemia virus antibodies after two weeks of age. However, the broiler progeny of immune broiler breeders frequently develop antibodies, so the effect of sub-clinical infection in horizontally acquired CAV was more than that of vertically acquired infection.14 Some findings indicate that CAV infection reduces broiler profitability and performance has major complications, so to decreases the losses associated with sub-clinical CAV infection there might be use of attenuated live vaccines. As it is an immunosuppressive viral disease, associated with other infections may also leads to severe economic losses. Some times CAV and IBDV synergisms (mixed infections) were also noticed in some birds. Though they both are immunosuppressive diseases, they always associated with secondary bacterial and fungal infections and cause high economic losses to poultry industry that has direct effect on Indian economy.

Immunosuppression

Chicken anaemia virus is an etiological agent responsible for multiple disease syndromes- haemorrhagic syndrome, aplastic anaemia , gangrenous dermatitis, haemorrhagicanaemia syndrome anaemia dermatitis and Blue-wing disease.15 Immune cells of the chicken are the first target cells of this virus. The virus infect B-cells in bone marrow and T-cells in thymus and cause destruction of these lymphocytes.16 The virus causes destruction of both T-helper and T-cytotoxic cells in the thymus and has direct effect on both humoral and cell mediated immunity in host system. CAV reduces the function of both macrophages and phagocytes. The immunosuppression leads to susceptibility of the birds towards other infections. CAV infection leas to multifactorial disease co-infection with avian reoviruseS and staphylococcus infections cause gangrenous dermatitis and Blue-wing disease.. anaemia, pericarditis, gangrenous dermatitis, necrotic enteritis and pneumonia are the common symptoms observed in birds that are infected with CAV. So the infection with CAV is associated with secondary bacterial and fungal infections. Finally the death of the birds occurs due to severe immunosuppression with opportunistic infections.17

General Characteristics of Chicken Anaemia Virus

Chicken anaemia virus is only the member of genus Gyrovirus, family Circoviridae. The virions are non-enveloped, icosahedral particles (fig 2.7) having the diameter of 23-25nm. CAV differs from other Circoviruses in size, morphology, buoyant density of 1.37 g/ml.18The estimated value of sedimentation co-efficient of CAV is 91S in sucrose gradient. CAV contain small single- stranded circular DNA as a genome having the size of 2.3 Kbp. The genome encodes for three viral proteins VP1, VP2 and VP3. Chicken anaemia virus causes the disease Chicken Infectious Anaemia, the clinical disease is noticed mainly in the young chickens of 10-14 days-old, which usually acquire the infection vertically from parent flock. Chicken infectious anaemia is characterized by aplastic anaemia, generalized lymphoid atrophy and immunosuppression. CAV induced cytopathecity in Marek's disease transformed cell lines (MDCC-MSB 1), which enable in-vitro virus isolation, facilitate virus purification and development of diagnostic assays.

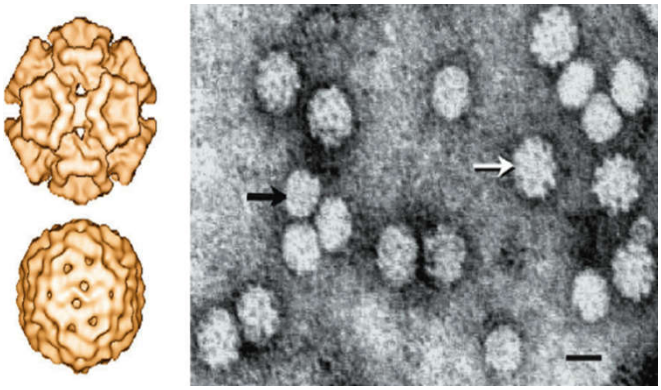

Fig 2.7 Cryo -electron microscopy image of a particle of an isolate of Chicken anaemia virus.

Source:https://veteriankey.com/circoviridae

Genome Organization

Chicken anaemia virus is a small unique among animal viruses having the diameter of 25 nm.19 Genome consists of circular single-stranded DNA.20The DNA multiplied in infected cells via Rolling-circle model. CAV strains isolated from different countries are having minor differences in their genomes, so all CAV isolates included under same serotype. The genome of the CAV having the size of 2.3 kbp.21 The transcript of CAV genome is an unsplicedpolycistronic mRNA encoding three viral proteins 50 KDa (VP1), 24 KDa (VP2) and 13.6 KDa (VP3 or Apoptin).22The 50 KDa protein was found from the purified CAV virion by SDS-PAGE, is a major capsid protein and attempts were also being made to develop diagnostic studies.23 Todd *et al*., 1990 reported 14 CAV isolates from seven different countries and assigned to seven groups on the basis of cleavage pattern by the restriction enzymes.

A polycistronic polyadenylated mRNA of 2.3 Kbp comprises of three overlapping open reading frames (ORFs) is transcribed from CAV genome, encodes for three viral proteins VP1,VP2 and V3. ORF1 encodes for VP1 gene which encodes major structural protein called capsid protein. ORF2 encodes for VP2 gene, a scafolding protein which is essential in virus replication and overlaps with ORF3, which encodes VP3 a non-structural protein named apoptin. The replicative form of CAV genome having 2298/2319 bp, contains three ORFs encodes for VP1, VP2 and VP3 genes, one promoter region and one poly adenylation signal. The promoter-enhancer region of four or five 21 bp Direct repeats and 12 bp insert is located upstream of ORF2.24 Many CAV strains contain four direct repeats with 12 bp insert in the middle. There is a hyper variable region in VP1 gene between amino acids 139-151,25 resulting in changes in amino acid composition that would alter the protein structure.26 The transcription requires the binding of transcriptional factors to DR (direct repeat) and 12 bp insert. The presence of fifth extra direct repeat enhances the transcriptional activity inin-vitro assays.27 Mutations in 12 bp insert resulted in decreased cytopathecity of virus particle.

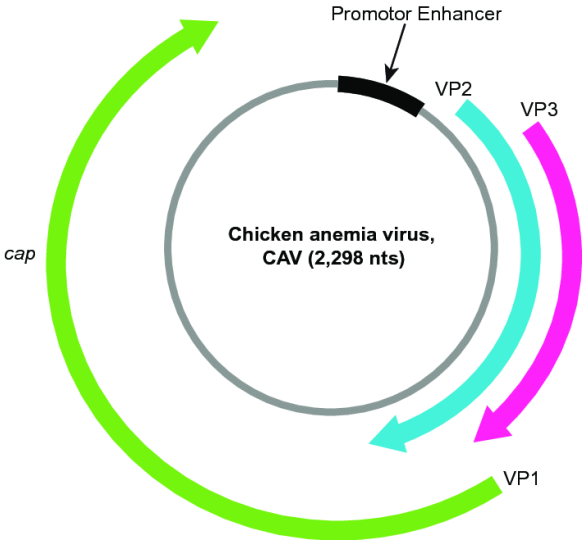

Fig 2.8 Schematic representation of genomic organization of Chicken anaemia virus

Source:https://www.researchgate.net/figure/Genome-organization-of-an-isolate-of-chicken-anemia virus_fig4_282876167

Viral Proteins and Their Functions

Chicken anaemia virus infected cells have the transcripts that encodes for three viral proteins of about 52 KDa (VP1), 24 KDa (VP2) and 14 KDa (VP3; apoptin).

Capsid Protein

The VP1 gene of CAV encodes for major capsid protein which plays an essential role in viral pathogenesis. VP1 needs the co-expression of VP2 for induction of neutralizing antibodies. Earlier studies indicate that the immunization with both VP1 and VP2 recombinant proteins elicits the protective immune response, where as separate expression of VP1 and VP2 does not have detected a polypeptide of Mw 50,000 in purified virus from CsCl density gradients.28 The N-terminal region of VP1 contains an amino acid tract, which is enriched with histones, are known for their ability to bind and protect the DNA with arginine rich content. So, the N-terminal region of the VP1 might bind to the ss- DNA within the capsid.

Scaffolding Protein

VP2 gene encodes for a non- structural protein with scaffolding activity. These scaffolding proteins act as scaffold for the formation of the so called light capsid, but are removed in the next step. IVa2 of adenovirus, pre-VP22a protein of herpes simplex virus are the other examples of this type of scaffold proteins.29;30;31 This VP2 scaffolding protein has also the protein phosphatase activity.32

Apoptin

The VP3 gene of Chicken anaemiavirus encodes for 13 KDa protein namely Apoptin. Apoptin protein composed of 121 amino acids and does not show any sequence homology with cellular protein. Apoptin induced programmed cell death only in transformed cells where as it does not induce apoptosis in normal cells. It induce selective death of cell lines derived from human tumours such as lymphoma, colon sarcoma, melanoma, breast and lung cancers. Nearly 70 human tumour cell lines shown susceptibility to apoptin.33Apoptin also induces apoptosis in SV40- transformed fibroblast or UV-irradiated

cells from individuals having hereditary cancer prone syndromes.34;35 The apoptin induces P53 independent programmed cell death in tumoral cells. Cellular capsases are functioned as initiators and executioners of apoptic process.

Host Range

Chicken anaemia virus has very narrow host range. All Circoviruses including chicken anaemia virus mostly infect the avian species. Recently acircovirus that infect humans was identified and named as TT-virus from serum sample of Japanese patient with initial TT.36 On the basis of structure and genome organization this TT-virus was classified under Circoviruses. Chicken is the only natural host for the Chicken anaemia virus, although the virus was found in turkeys but they doesn't show any infection.

Host Systems

Chicken is the only natural host for Chicken anaemia virus, which is ubiquitous not only in commercial domestic fowls but also in specific pathogen free stocks and both sexes are affected with this virus.37 When compared to layers the broilers were more affected.38 CAV was first isolated by Yuasa *et al*., 1979 in Marek's disease transformed cells, so the virus was cultivated in MDCC-MSB-1 cell lines. Embryonated chicken eggs, one day old specific pathogen free (SPF) chicks lacking maternally derived antibodies to CAV are suitable hosts systems for isolation of chicken anaemia virus.39

Assay of Cav

One-day old chicks were inoculated intra muscularly at the thigh with 0.1 ml of virus inoculum. At least four chicks were used for each inoculum. At 14 days of post-inoculation, their haematocrit values were determined and they were sacrificed to observe femoral bone marrow. Inoculated chicks were considered specifically infected with Chicken anaemiavirus when they showed a haematocrit values below 27.0% and when yellowish change of the bone marrow was recognized.40

Replication

CAV is a double stranded circular DNA virus. It replicates by rolling circle mode of replication by forming circular double stranded replicative form (RF). The genome of CAV encode for three genes VP1, VP2 and VP3. Both VP1 and VP2 genes were indispensable for CAV replication. But CAV was first isolated in Marek's disease transformed cell lines.41 The VP3 gene of CAV that encodes a protein called Apoptin responsible for apoptosis of transformed cells, so it replicates rapidly in transformed cells. These studies were concluded that VP3 gene of the CAV was required for the replication of the virus.

Pathogenesis

CAV was transmitted by both vertical and horizontal mode of transmissions. The horizontal transmission is by infected faeces, fomites and by direct contact. The vertical transmission through hatching eggs. When one day old specific pathogen free chicks were inoculated with this virus, the viremia was observed within 24 hours of infection and the virus was recovered from the organs of the infected bird for up to 35 days.42

Bone marrow atrophy, lymphoid atrophy and thymic atrophy are the main characteristic gross lesions observed in CAV infected birds. CAV infected chickens show severe anaemia and haemorrhagic aplastic anaemia syndrome, characterized by intramuscular, intracutanious and subcutaneous haemorrhages.43The virus causes depletion of haematopoietic tissue in bone marrow and it leads to yellowish colouration of bone marrow due to decreased RBC count. Particularly in CAV infections haematocrit values plays a key role. The virus causes drastic decrease in haematocrit values. This is the major symptom that observed in CAV infection, so the viral infection was also confirmed by haematological findings. The haematocrit values (HV) were severely affected in CAV infection. Haematocrit values below 27% indicate the severe anaemia and blood loss. The blood becomes watery and clot slowly leads to thrombocytopenia. Though it is an immunosuppressive disease, secondary bacterial and fungal infections were common in CAV infected birds. Gangrious dermatitis is most evident secondary bacterial in in CAV infected birds, gives the bluish-green colouration to the wings, so this disease is familiarly known as Blue-wing disease. Mortality rates may be higher than 50% and having 100% morbidity rate. The disease resistance begins at the age of two weeks after hatching the eggs. Maternally derived antibodies and age resistance can overcome the disease incident for some extent.44

Diagnosis

The diagnosis of CAV infection was primarily based on specific clinical symptoms and gross pathological findings. The virus was cultivated in embryonated eggs, cell cultures (MDCC-MSB-1 cell lines), SPF chickens. Secondarily the CAV infection was diagnosed by taking haematocrit values from infected birds. CAV infected birds shows less than 26% of haematocrit values that may indicate the virus infection. The antibodies recovered from the above procedures were used in the serological and immunological diagnosis of CAV infection.45Immune fluorescent technique,46staphylococcus co-agglutination test,47 immune peroxidase technique (Hoop and Reece, 1991) are the immunological procedures used for the diagnosis the CAV infection. The serological methods like serum neutralization test,48 virus neutralization test,49 Enzyme linked immune sorbent assay (ELISA),50 indirect fluorescent antibody technique,51 indirect immune peroxidase test were used.52 Polymerase chain reaction (PCR) was most apparently used molecular technique used for detect the CAV in infected tissue samples.

CONCLUSION

Based on this review it is concluded that the CAV causes an economically important poultry viral disease it has direct impact on all major poultry producing countries. A lot of work was done by several workers in earlier to understand the origin, genome organization and preventive measures of Chicken anemia virus. But there is no specific vaccine was produced for control this disease till now, due to the complication in expression of VP1 coat protein gene, so the work has to be extended for the expression of this VP1 gene to develop the specific vaccine against Chicken anemia virus.

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