International Journal of Animal Husbandry and Veterinary Science
Volume 3, Issue 3, ISSN (Online): 2455-8567

Health and Hygiene Guidlines for Ostriches

Dr Ghulam Abbas[*] and Syed Wasim Abbas[1]
[*]Department of Animal Production, Riphah College of Veterinary Sciences, Lahore.
[1]Department of Clinical Medicine and Surgery, University of Veterinary and Animal Sciences, Lahore.

Abstract **– Ostriches are large flightless running birds present on the earth as a species for over 40 million years. Ostriches can successfully be reared in temperate environment of Pakistan. Therefore, ostrich farms of high production potential are now gaining ground in the country. Although ostriches have natural resistance against most of the diseases but they are not outrange of probability of occurrence of diseases. Presently an outbreak of Newcastle disease (ND) has been reported around boarder areas in Pakistan due to negligence of health and hygiene (reluctant of following vaccination program) protocol. There is dearth of information and more misconceptions about the health and hygiene needs of this species. Consequently, it is of utmost importance to determine the health risks of ostriches domesticated for commercial purpose. Necessary information available about most of ostrich diseases, especially the detailed knowledge on prevalence of pathogens, vaccination protocol and diagnosis etc. is not sufficient. Most standard diagnostic tests used in the poultry are not applicable in ostriches. Hence, deep scientific research is required about the welfare, immunology and health of ostriches in Pakistan. Therefore, the intent of this article is to provide general information/awareness about health related issues of Ostriches.**

Keywords **– Ostriches, Farming, Health, Hygiene, Diseases, Pakistan.**

I. Introduction

Ostriches, *Struthio camelus* (Linnaeus, 1758) are large flightless (ratite) running bird of African origin present on the earth as a species for over 40 million years. Being desert birds these can be successfully reared in warm and extreme environment. Ostrich farming is prevailing for meat (healthy meat), fat/oil, hide, eggs, feathers and other products yet we are meeting just 10% of the customers demand. Major clients for meat are restaurants, hotels, meat markets (National and international) and super stores. After the excellent success of poultry industry in the country, ostrich farming is a new emergent in poultry production in Pakistan which can open new prospect for development of meat industry in the country. It is high time for Pakistan to capture its share in the local and international market. Pakistan being located in temperate region is an ideal country for ostrich farming and ostrich farms of high production potential can easily be set up in the areas where cheap labor and cheap feed is available. However, ostrich farming is facing some problems in Pakistan including managemental problems and health related issues. Recently an unexpected mortality has been reported around boarder areas in Pakistan due to little information about ostrich health and hygiene. It is of utmost importance to determine the health risks of ostriches especially those already present in domesticated or wild birds, migratory birds and fugitive birds. Therefore the purpose of this writing is to provide general information about health concerning issues of Ostr--ich farming.

How to Prevent the Diseases at Ostrich Farm

It is of utmost importance to identify the threats/health risks of ostriches. Costs of these health risks prevention and costs involved in a disease outbreak on ostrich farm should also be considered. In order to avoid/control the diseases strict biosecurity plan and proper Vaccination is essential. Segregation, cleaning, disinfection and traffic control are three main measures of biosecurity. HACCP (Hazard Analysis Critical Control point) based program involving strict biosecurity be must and regularly evaluated at ostrich farms.

Vaccination

To prevent disease transmission prevention has always been proven cheaper than cure therefore vaccination must be done in a timely manner. Vaccination is quite cheap. A Good vaccine procedure helps to avoid/reduce the

incidences of endemic diseases and increase the profitability of the farms. Therefore proper vaccination according to the advice of the local veterinary services is mandatory for successful ostrich farming (Abbas *et al.,* 2017). Newcastle disease virus caused high mortality in ostriches worldwide. Some cases are also seen in border areas of Pakistan. Vaccine against NDV of commercial poultry is reported to be effective in ostrich birds but at much higher doses than that of recommended for poultry birds. However research regarding the isolation and characterization of viruses in ostriches and preparation of vaccine is highly recommended according to geographical conditions of Pakistan. There are different schedule for ND vaccine adopted worldwide included the use of La Sota applied by eye drop/ spray into the eye between 6 and 8 weeks (W) of age and a booster dose of sub cut (S/C) injection of killed La Sota ND vaccine injected at the same time and/or within 3 weeks of applying the live Lasota eye drops (Blignaut *et al.* 1998). Vaccine is repeated at 6 months of age and after each year interval. Ostriches should be vaccinated against La Sota killed

vaccine 0.25cc/bird via eye drop, wings tip or spray into the eye at age of 3 and 6 weeks and subsequent sub cut (S/C) injection of an inactivated emulsified and/or alum precipitated La Sota killed 1cc/bird via wing tips be given at the 3 and 6 months of age. Vaccine is repeated each 6 months interval afterward. Haemagglutination inhibition test (Alexander, 1997), may sometimes give confusing ad/or false negatives particularly when titer is low (wright, 1996). Williams et al. (1997) found that the enzyme-linked immune-sorbent assay (ELISA) give 10 times more accurate results.

Ostriches of all ages may be susceptible to influenza infection Manvell et al (1998). Autogenous killed oil-based vaccine against influenza has been found to effective to induce better immunity (Allwright, 1996).

Struthio cumulus are also vulnerable to Pox virus of family *viridae.* Virus is reported to cause mortality up to 30% indisease endemic areas. Clinical symptoms include swollen, warty and brown nodes around the eyes particularly around the corners of mouth and beak. Immunity against the virus during an outbreak can be induced by vaccinating the birds commercial fowl pox vaccines at 2 weeks of age via wing-web puncture (Perelman et al., 1988).

Like other poultry ostriches are also at risk to many bacterial diseases. Strict application of bio-security can helpful to prevent these disease however to prevent anthrax or clostridiasis, vaccine against these disease is the best way to avoid the losses. A single dose of cattle anthrax vaccine is effective in preventing the disease when anthrax outbreak occurs (Theiler, 1912).

Clostridium perfringens types A and D are most feared ostrich diseases cause necrotic and haemorrhagic enteritis and Enterotoxemia in ostrich birds. Vaccination at 1 week of age against *Clostridium perfringens* type B and D is recommended to avoid losses (Snyman*et al.* 1992) and a booster dose should be administered at 30 days of age (Huchzermeyer; 1994). Necrotic Enteritis can also be avoided by vaccinating the birds Enterotoxaemia oil based vaccine 0.5 cc S/C at 6D; Lamb dysentery @ 0.5 cc S/C at day 7. Repeat the Enterotoxaemia (alum) vaccine @ 1 cc S/C at 4th week of age and Lamb dysentery vaccine @ 1cc S/C at 7 Week. Unvaccinated ostriches older than 24 weeks should be checked against viruses such as avian influenza, Newcastle disease virus etc.

Precautions: Vaccinate the ostriches where infectious agents are prevalent and always vaccinate only the healthy birds under comfortable conditions regarding the environment, feed, water etc. Purchase vaccines from a reliable company carrying in thermos flask at temperature 4°C to maintain the cold chain. Check expiry date printed vaccine label. Follow instructions printed on the label of the vaccine. Exact dose of vaccine should be administered in the way it is recommended. Use sterile needles and syringe for reconstitution. Keep the reconstituted vaccine in the ice to maintain the cold chain. Don't get haste keep accuracy through the vaccination procedures. Utilize the prepared vaccine as soon as possible and do not use reconstituted after 2 hours. Vaccination should be carried out according to the regulations and recommendations of manufacturers. Live vaccines should not be used in areas wherever the disease do not exist. Use clean equipments for vaccination. Do not vaccinate the birds during stress period. Burn/dispo--se of the unused vaccine vials.

Bio-security Measures at Ostrich Farm

Like poultry bird ostriches are vulnerable to a wide range of bacterial and viral diseases, the best way for prevention of disease is application of bio - security measures.

Following bio-security measures should carefully be considered at Ostrich farm Avoid anything being brought onto your farm.

For vehicles, construct a vehicle dip, where the wheels of the incoming vehicle have to pass through an authorized disinfectant. Try to prevent further movement of the incoming vehicle, by designing parking near the opening gate.

In any case, the person with appropriate footwear should pass through a foot dip, containing a disinfectant.

Safety measures regarding control of vegetation, rodents and arthropods (ticks etc.) should be considered. Hazard Analysis Critical Control point (HACCP) action plan be implemented and regularly evaluated at ostrich farms and also at products flow points.

Fertile eggs and day-old chicks should originate from flocks registered for risk against pathogens.

II. Problems/Disease of Growing Ostriches

It is usually said that ostriches are less prone to diseases. It can be correct for ostriches living in natural conditions. However, due to domestication and commercialization ostriches are now no longer considered disease free. It is impossible to say for any animal to be free from pathogens contact, even with controlled conditions diseases may occur. Ostrich's diseases may pose an economic threat to producers. Whereas, current scientific information/evidences of diseases of ostriches are not sufficient, fragmented and limited. Keeping in view the minimum probability of occurrence of disease incidences it is needed that awareness about diseases should be raised. Some problematic diseases of ostriches are discussed below:

III. Bacterial Diseases

Omphalitis (infection of umbilical area), or infected yolk sac (yolk sacculitis), is a common disease of hatchlings caused mainly due to E. Coli, characterized by loss of weigh, incomplete healing of the naval, retained yolk sac lack of body tones and vent pasting. Omphalitis is found to be very rare in naturally hatched chicks. Problem occurs once farmer assist to hatch a chick and/or tie off the omphalo-mesenteric vessels and bandage the abdomen. Chicks seen weak, hurdle together near the brooder and Naval is thick, prominent and necrotic. Yolk material is oozing from the naval making unpleasant (fowl) odor from chick.

Prevention: Improve the sanitary conditions of breeder farm and ostrich farm, Increase the frequency of eggs

collection to avoid the dirty eggs because fecal contamination is the serious source of infection. Proper egg storage, fumigate the hatchery, set clean eggs in hatchery, Set incubation requirements in ideal limits (avoid too high relative humidity in setter) avoid the chicks to stress and provide the best brooding conditions. Isolate the infected chick from healthy ones.

Treatment: Do flushing, if vent is closed, use good quality ground maize, Increase lucerne proportion in the diet. Remove the yolk sac by surgery in more serious situation. Give Tribressin 1cc/gallon water or Furazolidene 20g/feed bag or furazole 80g/feed bag for 5-7 days. Ampicillin and chloramphenicol are also effective.

Salmonellosis: *Salmonella* cause several diseases of economical and zoonotic importance. *Salmonella Typhimurium* and *S. Enteritidis* have been related with clinical conditions in young immune suppressed ostriches, (Huchzermeyer, 1997a; 1997b; 1998). These microbes are reported to cause high mortalities of ostriches and cross-species transmission under highly stressful situations (Vanhooser and Welsh, 1995). Disease is related to use of rodent-contaminated feed or feed ingredients, contact with fugitive birds, rodents and contaminated water (Jensen *et al.,* 1992; Tully and Shane 1996).

Postmortem examination shows ecchymotic to suffusive hemorrhages in the serosa of the gastrointestinal tract and parenchymatous organs, lesions are formed in the liver, spleen and lung, spleen is enlarged and congested the mucosa of the small intestine and colon is reddened with patchy ulcerations, enteritis and adherent fibrinous exudate. Liver congested and white spots appeared on liver (Huchzermeyer, 1998; Vanhooser and Welsh, 1995). Salmonella can be confirmed by valid serological tests using ELISA.

A sound bio screening procedure should be adopted during export of live ostrich and ostrich products. Older animals are typically able to carry and intermittently shed salmonellae for an extended period (Barrow, 1993; Jordan and Pattison, 1996). Although no clear evidence of *S. Gallinarum* or *S. Pullorum* Infection are found in ostriches however laboratory diagnosis and screening at farms is recommended to prevent any outbreak. Background risk status of already existing health issues in the importing countries must be considered. For this bio-screening of exporting ostriches and ostrich Products may also helpful.

Control: Strict biosecurity measures in ostrich slaughter houses, at deboning plants and during the removal of viscera are the best ways to prevent the disease. Broad spectrum antibiotics combined with complex probiotics is found to be useful.

Treatment: Proper disinfection and strict biosecurity measures along with use of mannose oligosaccharides @ 2 kg/ton of feed can prevent the disease (Huchzermeyer, 1998; Verwoerd *et al.,* 1998).

Clostridium botulism toxins (especially type c toxin) may cause serious mortality in ostriches. Birds showed characteristics symptoms of drowsiness, weakness, unsteady walking. Paralysis of leg, neck and wings in advanced stage.

Prevent: Good husbandry conditions and vaccination.

Treatment: Injecting antidote.

Avian Mycoplasmosis (Mycoplasma gallisepticum)

*Mycoplasma (*M. *gallisepticum*and M. *synoviae*) has been isolated from ostriches ((Shivaprasad, 1993; Peccati *et al.,* 1996) but the pathogenicity is reported to be suspected. Ostriches show respiratory symptoms. Mycoplasma can colonise the tracheas of young ostriches. A sound bio screening procedure should be adopted during export of live ostrich and screening at breeder farms may helpful to prevent any outbreak.

Treatment: Mycoplasmosis can successfully be treated with Tylosin at 300 mg/Kg in the diet of ostriches.

Fading Chick Syndrome is fatal disease of ostriches most often between 1 and 3 months may also affect chicks of up to 6 months age. Chicks become listless, stop eating and drinking and die. The etiology is not known. Aggressive intravenous fluid and/or oral fluid therapy has been successful in some cases.

Gastric Impaction occur in ostriches of all ages. Quantity of feces reduced and urine become thick and pasty. Birds show anorexia, general weakness, drooping wings, rough feathers, reduced number of defecations, dehydration and inability to stand. Macroscopic edema, erosion and hemorrhagic ulcers may be seen in proventriculus and ventriculus mucosa. Gizzard appeared filled with sand, stones, pieces of wood, threads, metal, glass and other non feed items. Birds show malnutrition symptoms. Problem can easily be detected by palpating the abdomen. Treatment can be surgical or non-surgical. Preventive measure include acclimation of chicks to a variety of substrates very early in life and avoiding sudden feed changes or sudden additions of high roughage feedstuffs.

Staphylococcus hyicus in ostriches cause conjunctivitis. Colobacillosis was reported for mortality (more than 20%) in young ostrich in flock imported from Belgium at RCVetS Lahore. Tuberculosis in ostrich and other ratites is also reported. *Pasteurella multocida* infections may cause generalized and pulmonary infections in ostriches.

Diarrhea is the most common in ostriches. In young chicks it mostly occurs at 8–12 days of age when the yolk sac is resolved and chicks start eating well. In case of diarrhea due to over eating, active chicks need no treatment of diarrhea. Sudden change in diet may also cause diarrhea for which treatment with probiotics is recommended. Bacteria (E. *oli, Pseudomonas species, Salmonella species, Streptococcus species, Staphylococcus species, Klebsiella species, Campylobacter jejuni, Clostridium perfringens, Clostridium colinum and Mycobacterium species cause diarrhea in ostriches*.

Proper antibiotic recommendation based upon culture and subsequent microorganism isolation and sensitivity test could cure the diarrhea. Viral strains including *Adenovirus, Coronavirus, Paramyxovirus, Reovirus, Herpesvirus, Birna-like virus* and *Enterovirus* also cause diarrhea, however only supportive therapy is possible for viral diarrhea and potential application of biosecurity measures can prevent the problem. Overmedication and excessive electrolyte supplementation can cause enteritis. Another reason of diarrhea is gastric obstruction which can successfully by treated by surgery. Diarrhea relating to

protozoa can be treated by metronidazole.

Pasteurellosis: Ostriches are rarely reported to suffer in Haemorrhagic septicemia caused by *Pasteurella multocida.* Pasteurellosis has caused deaths to illness in zoos in Nigeria (Max, 1900; Okoh, 1980). Clinical signs include anorexia, high fever, lacrimation, runny nose, salivation, neck dropping, shivering and conjunctivitis. Post-mortem revealed air sac infections, conjunctival and pharyngeal oedema, hemorrhagic tracheitis, splenic abscesses generalized congestion of liver, spleen and pancreas, with petechiae and ecchymoses on the epicardium, endocardium, stomach, kidneys and intestines (Max, 1900; Okoh, 1980).

Control: To avoid the problem improved bio-security plan should be followed especially regarding rodents and fugitive birds control and ostrich be exported with clearance certification.

Treatment: Mycoplasma can easily controlled with synthetic penicillins for a period is 5 – 10 days or enrofloxacine 10% for a period is 5 – 10 days.

Treatment for Most of the Bacterial Diseases

Gentamicin 2 mg/lb, Amoxicillin 5mg/lb, Tetracycline 7.5 mg/lb, Tribrissen 2ml/kg, Sulfadiazine 48% 20 mg/lb.

Anthrax

Anthrax is an acute disease of global prevalence of poorly drained alkaline soils (Blood and Radostis, 1989; Coetzer *et al.* 1994) characterized by septicemia and rapid death with the exudation of tarry blood from the body orifices of the dead body. *Bacillus anthracis* is causative agent of this fatal disease. *Bacillus anthracis* forms highly resistant spores upon exposure to air, which propagate in polluted environment. Ostrich is the only bird notorious to be vulnerable to anthrax, perhaps due to normally lowered body temperature compared to other birds (Huchzermeyer, 1998). Anthrax fever, anorexia, petechial haemorrhages on the pleura and peritoneum, congestion of the intestines, a normal or enlarged spleen and sudden death are reported in most of the Anthrax cases (Robertson, 1908; Theiler, 1912). By standard smears very dark pulp and typical *B. Anthracis* bacilli are seen in the blood of infected ostriches. Strict bio-security, proper vaccination and avoiding the use of bone meal in ostrich feed can prevent the problem whereas in case of Anthrax incidence penicillin may be an effective treatment therapy.

Campylobacteriosis

Campylobacteriosis caused by *Campylobacter jejuni* resembled vibrionic hepatitis in poultry. Campylobacteriosis has been reported in young ostriches prone to severe stress causing up to 40% mortality. Ostriches show anorexia, depression, dehydration and green urine. *Campylobacter* is part of the natural micro flora of the GIT of birds (Oyarzabal *et al.,* 1995), however ostriches can get these through cross contamination. Disease is associated with outbreak of enteritis and hepatitis in young ostriches.

Control: Campylobacter-associated mortality or morbidity can be prevented by improving management and biosecurity. The areas where prevalence of *Campylobacter jejuni* is known, an autogenous inactivated *Campylobacter* bacterin vaccine (oil based +vitamin E) should be injected on arrival of chicks,

Treatment: For young chicks, give Furaltadone @250 mg/1 drinking and for older ostriches, give Norfloxacin @30 mg/kg live weight (Perelman *et al.,* 1992) or Danofloxacin at 5 mg/kg, coupled with complex probiotics in the food.

Chlamydiosis

Chlamydiosis caused by *Chlamydia psittaciis* is disease of zoonotic importance and has been reported to be found in most of the species of birds (reported in at least 30 orders of birds) (Schachter, 1989). *Chlamydia psittaciis* is difficult to eradicate completely; sporadic cases and epidemic persistently occurs. *C. psittaci* can be detected by culture, serological testing, immunoassays (sensitivity of these tests is unknown) and PCR amplification of chlamydial nucleic acid sequences (reliable test). Affected birds show anorexia, exhaustion, ruff feathers, oculonasal discharge, kerotoconjunctivitis, sneezing, respiratory distress, dehaydration and morbidity. Green to yellowish feces also be seen in some cases. Neuropathological signs may also develop in sub-acute to chronic form including convulsion, tremors, opisthotonos, torticollis, trauma and leg paralysis.

*Chlamydia psittaciis*is resistant to acid or alkali however it is vulnerable to numerous disinfectants like quaternary ammonium compounds, iodophore, chlorophenols, formaldehyde, glutaraldehyde, sodium hydroxide and isopropyl. *Chlamydia psittaciis* can be killed by moist heat of 250°F for a minimum duration of 15 minutes, and dry heat of 320-338°F for 60 minutes a sound bio screening procedure should be adopted for birds that have regular contact with the public i.e. during export of live ostrich and ostrich products etc., help protect humans. Birds should be imported from well reputed supplier, and be examined by an avian specialist. Strict biosecurity, good management along with good hygiene i.e. frequent hand washing etc. can prevent the problem.

Spongiform Encephalopathy

Bovine spongiform encephalopathy (mad cow disease) is a fatal disease causes spongiform brain lesions, ataxia, imbalance, uncoordinated feeding and central nervous symptoms. similar nervous conditions may also occurs in case of Newcastle disease, Borna disease, neoplasia, mycotoxicoses, lead poisoning, Western equine encephalomyelitis, Eastern equine encephalomyelitis, spongiform encephalopathy, hepatic encephalopathy gastric impaction (hypoglycaemia), trauma, pain, *Clostridium botulinum,* bacterial septicemia, *Chandlerellaquis coli, Balyascaris procyonis* and gangliosidosis (Vorster and Olivier, 1998). However most commonly nervous signs appear in ostriches are due to bacterial septicemia, toxic ingestion, nutritional etiology and hypoglycemia. Disease can be diagnosed by examination of brain tissue and the demonstration of scrapie-associated fibrils by electron microscope (Wells *et al.,* 1994). It is advised that ostrich rations should not contain carcass meal Kirkwood and Cunningham, 1994; Schoon *et al.,* 1991).

IV. Parasitic Infestation

Both ecto and endo parasites affect the performance of ostrich birds. Ostriches reared in confined houses are less prone to parasites infestation as compared to those of living in wild/natural habitat. Include; ticks of species *Amblyomma spp, Argus, Haemaphysalis, Hyalomma spp* and *Rhipicephalus spp,* mites of species *Pterolichus spp*, lices of species *Struthiolipeurus spp*, mosquitoes of species Aedes spp and Culex and flies of species *Struthiobosca spp* and *Pseudolynchia canariensis*. Besides their own harmful effects they cause on ostriches ctoparasite are also potential source of transmitting Bacteria (*Clostridium spp)*, *protozoa (Eimeria spp),* nematodes (*Libyostrongylusdouglossii*) and cestodes including *Houttuyniastruthionis* species *(*Davie*, 2015;* Pesenti *et al.,* 2015; *Mostafaviet al.2013;* Bala*et al.,* 2011).

Some external parasites like ticks may serve as vectors of viruses i.e. Crimean Congo haemorrhagic fever, (CCHF) a very fatal zoonotic disease of ostriches also affect humans. Causative agent of CCHF is a RNA virus of the genus *Nairovirus,* this virus is mostly prevalent in Africa, Asia and Eastern Europe. Virus has been isolated from 30 species of ticks, however most prevalence is reported closely with that of *Hyalomma marginatum, Rhipicephalus nossicus, Dermacentor marginatus* (Hoogstraal, 1979), bontpoot ticks (*Hyalomma rufipes* and *H truncatum*), two or three host ticks. Tick infestation has been reported in humid and intense vegetative climate (Van Niekar *et al.,* 2006). Few reports showed that migratory birds carry immature ticks whereas domestic chicken found to develop transient viraemia of very low intensity and an antibody response of only a few weeks duration therefore are not able to infect ticks (Hoogstraal *et al.,* 1961; Hoogstraal *et al.,* 1963; Shepherd *et al.,* 1987; Shivaprasad, 1993). Cattle, sheep and small mammals shows only mild fever and viraemia for up to one week, whereas clinical signs develops only in humans, resulting in roughly up to 30% mortality (Swanepoel, 1994).

Ostriches are more prone to virus compared to other birds (Hoogstraal, 1979; Shepherd *et al.,* 1987) 17 workers at an ostrich abattoir in South Africa (oudtshoom) suffered in CCHF after make contact with a group of ostriches having heavy tick infestation and out of these one patient died. CCHF virus in meat of any animal or bird does not cause a public health hazard (Hoogstraal, 1979; Swanepoel, 1994; Swanepoel, 1986), however safety/safeguard measures should logically be adopted (Swanepoel, 1994; Swanepoel, 1998) to confirm the use of healthy meat. Usually no clinical signs of CCHF are observed in ostriches and viraemia occurs round about four days. Virus can be isolated from blood and organs. ELISA, C-ELISA (Burt *et al.,* 1993) or sandwich ELISA using conjugated antiserum to ostrich immunoglobulins (Ig) (Swanepoel, 1994) and viral genetic material can be identified by reverse transcriptase-PCR (RT-PCR). By day thirteen post-infection, serum antibodies can be quantified (Capua, 1998; Swanepoel, 1998).

Argas persicus ticks carries rickettsial organism that causes **cowdriosis** (Heartwater) cattle, sheep, goats, wild ruminant and ostriches. Ticks and their larvas suck the blood of the host and may cause severe anemia. Ticks {*Acani: Ixodidae* e.g. *Hyalommaand Ambylomma spp*.} most commonly (80%) attack the head and neck area of ostriches. Bayticol aerosol spray having Flumethrin (Pyrethroids) as an active ingredient is effective prevent ticks and tick born disease or inject the birds with Ivermectin. However preparations containing Lindane are reported to be highly toxic to ostrich birds.

Mosquito of the order Culicidae carries *Avipox virus (*enveloped double stranded DNA virus*) to ostriches (*van Riper C. and Forrester, 2007). Flies are vectors of Leucocytozoon struthionis and Plasmodium struthionis which transmit filariosis or fowl pox virus (Mathison B.A. and Pritt, 2014). Flies and mosquitoes also cause stress in ostriches by biting. Use 5% carbaryl dust at 14 days interval is good option to remove the flies.

Licesmay damage beautiful feather of ostriches thus effect the performance of the birds and profitability of ostrich farm loss economically. To control lices use Bayticol, Pyrethroids group are one of the safe pesticide. Ivermectin may also be used against sucking lice with repeated doses.

Feather mites (*Gabuciniabicaudat, Pterolichusbicaudatus*) belonging to family *Pterolichidaeare* reported to infest ostriches. These mites reside in the ventral groove vein of the feather shaft where these suck blood and feed on gelatinous matter of feather sheath, reduce the beauty of the feather and cause economical losses.

Mites bite the skin due to which ostriches pull their own feathers and skin. Stress caused by mites thus may largely disturb the ostriches and ostrich can even suffer to respiratory, reproductive and gastrointestinal disorders. Mite infestation can successfully be treated with Ivermectin @0.2 mg/kg at 30 day interval. Spraying 1ml/l of 15% Cypermethrin solution is also an effective remedy to the control of mites in ostriches. Struthiolipeurusnandu (Arthropod) infestation in ostriches causes feather loss.

Abbas *et al.* (2016) use Ivermectin and Piprazine citrate in poultry and recommended that Piperazine citrate is more effective. These anthelmentics and other drugs given a 1-month intervals beginning at 1 month of age will prevent. Endoparaites live inside the body of ostriches where they eat the host's food.

Cestodes (Tapeworms) "*Houtyniastrutionis*" are long (50 to 100 cm) and flattened worms reside in the small intestine of ostriches (Deeming, 1999). These feed on nutrients from the ostriches. Animal loss weight, looks lethargic and emaciated, some time have mild diarrhea (Taylor *et al.,* 2007). Mature tapeworm segments are looked like white grains of rice in droppings and be confirmed by flotation techniques (Cooper, 2005). To control cestodes, Lintex combats at every three days is effective or fenbendazole @15 mg/kg, orally, for 5 days (Jurajda, 2002), or resorantel @130 mg/kg, or Oxfendazole @ 5 mg/kg orally may be effective (Taylor *et al.,* 2007; Cooper, 2005; Jurajda, 2002; Deeming, 1999).

The wire worms (*Libyostrongylusdouglassii*) are stomach nematodes of the gastric system causing libyostrongylosis (rotten stomach) in ostriches (Blood *et al.,* 2007; Taylor *et*

al., 2007). *Libyostrongylusdouglassii* are small (3mm long), round, wire like and yellowish red (Taylor *et al.,* 2007). Mature *Libyostrongylusdouglassii* resides in the vault of the glandular part of the proventriculus and gizzard wall (Deeming, 1999). Young chicks are at more risk for invasion. They grow poorly, are anaemic and death losses may be heavy.

Libyostrongylusdouglassiican do impaction of the stomach resulting in a high mortality in ostriches (Blood *et al.,* 2007; Dingle and Shanawany, 1999). These worms are too small to see trichostrongyloid eggs can be observed under microscope in the fecal sample of affected ostriches. Libyostrongylosis can be treated by ivermectin @ 0.2 mg/kg orally or 0.3 mg/kg subcut, levamisole @ 30 mg/kg orally (Dingle and Shanawany, 1999; Jurajda, 2002; Taylor *et al.,* 2007). Levamisole at each month to young and at after each 3 months to adults can successfully prevent libyostrongylosis (Jurajda, 2002). Pavacur has also been proved a drug of choice against libyostrongylosis.

Philiphthalmusgralli (eye fluke) is enormously small 2-3 mm (Kocan and Crawford, 2007; Cooper, 2005) and infest the eyes of ostriches. It lives in the conjunctival sac of the eyes where it may cause lacrimation and conjunctivitis. *Philiphthalmusgralli* competes its life cycle in snails as intermediate hosts. *Philiphthalmusgralli* can be controlled by applying 5% Carbamate powder on conjunctival sac and repeating the treatment after 2 days interval.

Histomonas meleagridis causes blackhead disease in gallinaceous birds, cause inflammation of caeca and liver. Ostriches reared in close vicinity of these birds may suffer in disease (Deeming, 1999; Jurajda, 2002). Furazolidone and Metronidazole are effective against Histomoniasis in ostriches (Jefferey, 1996).

Ostriches having close contact with doves and pigeons can be infested by *A Trichomonas*. This protozoa causes pseudomembranous lesions in the upper digestive tract (Deeming, 1999). To avoid the problem strict bio-security plan should be followed and ostriches should be reared separately away from the fugitive birds. Dimetridazole @ 50 mg/kg body mass is an effective remedy against the disease (Deeming, 1999).

Protozoa (*Eimeria* spp.) cause serious production losses in ostriches. Coccidiosis has been reported throughout the glob where ostriches are reared in confined houses Clinical symptoms are not very clear. Infested birds show anorexia, general weakness, bent posture, drooping wings and bloody diarrhea.

Prevention: proper vaccination, reducing the dampness conditions in the house and ammonia fumigation of the house can successfully prevent the disease (Dingle and Shanawany, 1999).

Treatmen: Use anticoccidial drugs i.e. Amprolium 1cc/L, use stenrol 1-2 kg/ton feed. Use clopido 25g/feed bag during rainy season. Also use sulphonamides, Vit. A &k.

V. VIRAL DISEASES

Newcastle Disease (ND):

Struthio camelus are moderately susceptible to Newcastle Disease (Rani Khet). ND in ostriches was reported to be restricted to zoos and circuses ostriches only (Corrado, 1966; Kauker and Siegert, 1957; Kloppel, 1963; Placidi and Santucci, 1954). Prevalence in farm ostriches was first reported in Israel in 1989 (Perelman, 1993; Samberg *et al.,* 1989). In an experiment ostrich chicks (3 months old) were infected with velogenic sstrain (Israel 67'), virus caused about 80% mortality within five to ten days. Virulent Newcastle Disease Virus (NDV) caused high mortality in ostriches at ostrichfarms in South Africa in 1993 (Anon, 1994; Huchzermeyer, 1996; Huchzermeyer, 1997; Huchzermeyer, 1993; Verwoerd, 1995) which then also affected the ostrich farms in Zimbabwe, Namibia and Botswana. It is the most panic disease of ostriches worldwide and prevalence of NDV have recently (start of year 2018) been reported in boarder areas of Pakistan (Punjab) indicating high mortality. Young animals are enormously prone to this disease. Clinical signs of disease include anorexia, apathy, ataxia and torticollis.

Duration of Newcastle Disease in mature ostriches is likely to be 3-16 days period (Verwoerd 1995). Clinical signs are more pronounced in younger birds between five to nine months of age. Nervous signs include nerves in-coordination, atonic paralysis of the neck, limped neck and head bent in a torticollis posture or three-legged position with the head on the ground, edema of the head (face and around the eyes), rhythmic twitches of the muscles of the back, staggering backwards, swinging sideways, inability to stand up and total paralysis (Samberg *et al.* 1989). Various a clinical symptoms such as respiratory distress because of, have also been observed at farm located at the border areas of Lahore (Pakistan).

The ostriches examined at RCVetS, Lahore showed petechiae hemorrhages on serosal surfaces, paint brush hemorrhages in the gizzard below the koilin layer, subcutaneous head and neck oedema, hemorrhagic tracheitis, splenomegaly and perivascular lymphocytic cuffing was also seen in the brain. Coughing and gasping may occur within 6-12 days. Disease can be diagnosed by isolation of NDV from brain tissues and blood test for anamnestic response (HI titer). HI test should be repeated fortnightly basis. Stable conjugated antisera to ostrich Ig for indirect ELIS can be (31,161) used as standard practice test. RT-PCR is most accurate/ validated interpretation of NDV.

There is scant information about the immune response of vaccine in ostriches, yet some researchers have reported the successful use of vaccine. Prevalence of NDV was detected at ostrich farms in remote areas of Lahore (Pakistan) therefore most of the ostrich flocks were vaccinated against NDV by the expert team of Riphah College of Veterinary Sciences, Lahore (Pakistan). Vaccination gave good response and mortality was not seen in vaccinated flocks. In field practices ostriches are vaccinating against NDV with commercial chicken vaccines, however strains of NDV from ostriches should be isolated and vaccines for ostriches should be prepared on commercial scale.

All wright (1996) studied many vaccine regimens and reported that vaccine be efficacious at 4 and 14 months of age. He also reported some reactions with adjuvant vaccines, especially oil-based killed vaccines. Verwoerd *et al.* (1997) reported no clinical signs or mortality in grown ostriches

(more than ten months of age) that were vaccinated with live La Sota vaccine at 6 and 10 weeks of age and 3 ml Killed vaccine (Aluminium hydroxide adjuvant) given 4 weeks before they challenged with NDV. However ostriches not vaccinated showed 100% morbidity and 25% mortality in the same conditions. Bolte *et al.* (1999) recommended a regimen of live vaccine (La Sota) via eye-drop and two doses of killed vaccine (oil emulsion) for high antibody levels in susceptible ostriches. According to Huchzermeyer (1994), ostriches can successfully be vaccinated by starting primarily with Live vaccine (Lasota eye drop) and then killed vaccine @ twice the recommended dose of poultry at 3 weeks after live vaccine, thereafter repeating the killed vaccine after 6 moth and yearly interval for grower and breeders ostriches respectively.

There is no specific treatment for ND, strict bio-security measur3es and proper vaccination is necessary to avoid the problem. During an outbreak of ND, vaccinate all the apparently healthy birds. Do flushing with Antitox in case of nephritis. Give antibiotic Lincocine plus colistin 1gm/8 liter water in case of severe enteritis; also give immunity booster (Novacoc forte etc) 1cc/liter water (we, at RCVetS, obtained good results using this treatment therapy whilst combating the ND outbreak at some ostrich farms at border areas of Lahore).

Infectious Bursal Disease Virus (IBD):

Ostriches may be susceptible to infection with Infectious Bursal Disease Virus (IBDV; an RNA virus) but are resistant to its clinical manifestations (Lombardo *et al.,* 2000; McFerran*et al.,* 1980). Infectious Bursal Disease (IBD) caused by IBDV of family *Birnaviridae,* genus *Avibirna virus. Avibirna virus* was detected in ostriches in USA where it caused high mortality (Tully and Shane, 1996). Birnavirus-like pathogens were also isolate in affected ostriches flocks in USA and UKA (Gough *et al.,*1998; Shivaprasad, 1993) serotype 1 virus was isolated from two 8- week-old ostrich chicks (Struthiocamelus) that had lymphocyte depletion in the bursa of Fabricius (Lombardo *et al.,* 2000).

Parvovius type 2 is highly contagious, affects the immune system of ostriches destructing the lymps and bursa fabricia. Virus prevalent worldwide in all major poultry producing areas affecting mainly chicken though Turkey, Guinea fowls and Ostriches may also be at risk.

Control: Strict bio-security measures and proper vaccination is necessary to avoid the problem. Eggs should be sterilized by washing with virucidal disinfectant to avoid contact of any known or unknown viruses and serological screening with the AGID test will be done routinely to check both type 1 and 2 antibodies.

Treatment: There is no specific treatment for IBD however supportive therapy can be given as in all other cases of viral infection. During an outbreak of IBD, vaccinate all the apparently healthy birds. Give simple diluted feed to animals. Do flushing with Antitox in case of nephritis. Give antibiotic Lincocine plus Colistin 1gm/8 liter water in case of severe enteritis. Use Paracetamol solution 1cc/ liter water; also give immunity booster (Novacoc forte etc) 1cc/liter water.

Avian pox is more frequent in ostriches. Characterized by formation of lesions and scabs on soft parts of body, caused by virus of genus *Avipox* and family *viridea* Typical, crusty granulomatous, microscopic and macroscopic warty, brown, swollen lesions are appeared on the mouth and beak, bas of the tongue, larynx, pharynx, throat, around the corners of eyes, external ears and neck. Virus is spread by air or biting insects, mainly through mosquito (cules and Aides). Gasping and suffocation occurs due to material in the larynx. Incubation period of virus in ostriches ranges 6-10 days. Usually mortality is low (15%) which may prevail due to suffocation.

To control the prevalence keep mosquito away from the ostrich farm. Vaccinate (wing web) the flock at 10-14 days of age. Apply silver nitrate, Vaseline or tincture iodine on scabs for five days to avoid secondary problem (Staphylococcal dermatitis) in affected animals. Mix 7gm TM-200 or Oxytetracyclin 125gm per feed bag also provide vitamins. If disease occurs but 30% flock affected and others show no symptoms then remove the scabs from the affected birds and provide the ground scabs to healthy birds in drinking water. Before using ground scabs, give broad spectrum antibiotics and vitamins.

Avian influenza was known to be caused by virus in 1901. These viruses were named as fowl plague viruses also called highly pathogenic avian influenza (HPAI) viruses. Influenza A viruses of 15 known haemagglutinin subtypes have been isolated from avian domestic and wild species throughout the world (Stallknecht and Shane, 1988). Influenza viruses have considerable ability to be mutated to higher pathogenic strains due to gene mutation or reassortment (Eckroade*et al.,* 1984; Villareal-Ch and Flores, 1998). The capability of avian influenza viruses to cause outbreak of respiratory disease and even high mortality in humans is of special concern (Alexander, 1982; Kaplan and Webster, 1977; Subbarao *et al.,* 1998). Report of virus isolation from human thought to have acquired infection from handling slaughter ostrich. Severe outbreaks of avian influenza (AI) have been reported in South Africa in 1970 and 1980.

First outbreak of influenza (H7N1) in ostriches was reported in 1991 and 1992. During this decade out breaks of Avian influenza were reported i.e. H5N9 was reported in1994, H9N2 was reported in 1995, H6N8 was reported in 1998 in South Africa, and H5N2 in Zimbabwe in 1995, however these virus serotypes were not virulence for chickens (Allwright t al., 1993;Allwright, 1992; 1996; Anon,1991; 1994; Burger, 1992). Allwright (1996) and Manvell *et al.* (1996) reported prevalence of H9N2, H7N1, H5N2 and H5N9 in ostriches in South Africa and Denmark (Jprgensen et al, 1998). H7N1 virus was also reported in ostriches in Italy, (Capua *et al.,* 2000). In Saudi Arabia, 14 separate outbreaks of H5N1 were prevailed in between 2003 to 2007. In one outbreak about 13,500 ostriches and about 4 million poultry were culled-off to contain the disease (SPA, 2007).

Manvell *et al.* (1998) reported that an H5 strain that was found to be highly virulent to domestic chicken was not pathogenic to ostriches of two weeks of age as they did not show any clinical symptoms. Ostriches of all ages may be

susceptible to influenza infection; birds excrete bright green urine and mortality is much higher (>90%) among young birds of less than 4 months of age.

Clinical Signs: Clinical signs include anorexia, respiratory distress, rales, gasping, lacrimation, sinusitis, edema of face and eyes, eggs production completely stop or drastically reduced. Mortality may reach up to 70%, however, the relationship between the virus and host can be complex.

Postmortem examination: Post-mortem lesions include enlarged, mottled and friable liver with coagulative necrosis and vasculitis. Necrosis may also be present in pancreas and spleen. Congested small intestine necrotic areas on the tips of the villi are also common.

Serology: Virus can be detected using serological tests like HI, Agar Gel Immune-diffusion (AGID) and C-ELISA.

Vaccination: Live virus vaccines have the ability of this virus to prevalent and cause mixed infection in the same hosts pecies also may cause gene reassortments and probably virulent mutant progeny (Alexander, 1982; Alexander, 1995). Autogenous killed oil-based vaccine against influenza has been found to effective to induce better immunity (Allwright, 1996).

Control: Vaccination, Strict bio-security plan, preventing contact between farmed ostriches and wild birds and honest certification regarding screening of exported ostriches can prevent the outbreak.

Treatment: No specific treatment however treatment plan comprising fluids and antibiotics against secondary bacterial infections as described for other viral diseases can be followed as an effort to reduce losses to minimum limits.

Adenovirus Infections

Adenovirus is a DNA virus of the family *Adenoviridae,* genus *Aviadenovirus.* Adenoviruses are widespread in poultry all over the world. Avian adenoviruses are categorized into three groups: 1) conventional group 1 fowl adenoviruses (FAV-1 to FAV-12), 2) adenovirus reported with egg drop syndrome (EDS 76)1976, 3) type II fowl adenoviruses (turkey haemorrhagic enteritis virus, marble spleen disease virus of pheasants, and the avian adeno-splenomegaly virus of chickens) (Jordan and Pattison, 1996). Adenoviruses are reported to cause wasting disease in young ostriches in USA.

Borna is caused by a single stranded RNA virus (enveloped non segmented negative-strand RNA virus) of family *Rhabdoviridae.* Borna disease virus is one of the oldest viruses which may access to the central nervous system. The disease is present in Central Europe (USA, Japan, Sweden) and the Near East but its prevalence in other countries has not been reported. Borna disease in ostriches has only been reported from Israel. Ostriches are reported to be naturally infected with Borna (Richt*et al.,* 1992;, Rott and Becht, 1995; Becht and Richt, 1996; Ashash *et al.,* 1994; 1995; 1996). Disease can occurs either by direct contact through nasal, salival, conjunctival secretions or through contaminated feed, however disease is not highly infectious. Borna primarily cause hyperthermia, anorexia, colic, and constipation and at advanced stage a range of neurological signs including paresis depression, circular movement, standing in awkward positions, collapsing, running into obstacles, and paralysis may occur. Affected birds show lesions of neuronal necrosis, satellitosis, neuronophagia and multifocal gliosis in the lumbar spinal cord (Ashash *et al.,* 1994; 1995; 1996). Disease can be confirmed by ELISA and histopathological evidences. The immunization of serum from affected ostriches to ostrich at risk is an effective preventive protocol to avoid of further disease (Ashash *et al.,* 1994; 1995; 1996).

Wesselsbron Disease

The causative agent of Wesselsbron disease is an RNA virus of the family Fl*aviviridae,* (genus Flavivirus). No strain variation has been reported. The disease is an acute arthropod (*Aedes* spp. and Ixodid tick) borne infection and endemic in Africa. Wesselsbron virus has been isolated from tissues of young ostriches however virus did not affect ostriches. Laboratory diagnosis is performed by virus isolation (intracerebral inoculation of new-bom mice, eight-day-old embryonated chicken eggs and cell culture) and serological tests (complement fixation, virus neutralization and ELISA).

Control: Vaccination, Strict bio-security plan, preventing contact between farmed ostriches and arthropods can prevent the outbreak. Honest certification for sero-negative results of exported ostriches can prevent the prevalence of virus innon-endemic areas also exportshould be allowed during the season when there is less risk of arthropods contact.

Equine Encephalomyelitis

Vaccination of emus for this disease is necessary in areas where the virus exists; Eastern equine encephalomyelitis is caused by members of the genus *Alphavirus* of the family *Togaviridae.* equine encephalomyelitis cause high mortality in domestic fowls, quails, pheasants and chukars in America however the disease is limited to North, South and Central America. Mosquitoes serve as vehicles of transmission of virus and the horizontal spread within flocks is mainly by feather picking and cannibalism (OIE, 1996) or by the faecal-oral route (Brown *et al.,* 1993). Virus causes flu-like condition, acute haemorrhagic enterocolitis and viraemia up to a week, followed by long-lasting immunity (OIE, 1996; Thomson, 994).

Equine encephalomyelitis is reported to be fatal (morbidity rate of up to 70% and mortality of up to 87%) in ostrich chicks and may cause fading chick syndrome (OIE, 1996; Smith, 1993), Vaccines used in horses can safely be used to stimulate immune response in ostriches in virus prevalent areas (OIE, 1996; Tully and Shane, 1996).virus can be detected by HI, ELISA and plaque reduction neutralization tests.

Control: Vaccination, Strict bio-security plan, preventing contact between farmed ostriches and mosquitos can prevent the outbreak.

Treatment: No specific treatment however treatment plan comprising fluids and antibiotics against secondary bacterial infections as described for other viral diseases can be followed.

Corona Virus Infections of Ostriches

The causative agent is an RNA virus of the family *Coronaviridae* and the genus *Coronavirus.* A Coronavirus has been isolated, along with a wide range of bacteria and

other viruses, from young ostriches affected with an enteritis. However, the Coronavirus may not have been the primary cause of the syndrome. A coronavirus-like pathogen was identified in a young rhea chick causing general weakness, ataxia and death. A new species of Coronavirus has also been found in ostriches associated with a chronic 'fading' syndrome or explosive outbreaks (Frank and Carpenter, 1992; Kennedy and Brenneman, 1995; Tully and Shane, 1996). The virus can only be identified using EM To avoid the transmission of corona viruses, ostriches having seronegative test result for viruses, only be qualified for export.

Although ostriches can be susceptible to viral diseases discussed above however, Avian Influenza and Newcastle Disease are two main ostrich diseases in Asiatic region of the globe.

Fungal Diseases

Aspergillosis (moldy disease/brooder pneumonia) is fungal infection of respiratory tract in ostriches that causes noteworthy economic losses to ostrich producers worldwide. Disease is caused by inhalation of spores of *Apergillus fumigates* from moldy environment and has a zoonotic importance. *Apergillus flavis and Apergillus niger* have also been isolated in various cases of Aspergillosis in young ostriches. Ostriches do not show respiratory distress or coughing. Clinical signs appeared are depression, loss of appetite, stunting and mortality up to 50%. Postmortem lesions reveal small creamy color plaques present on lungs, trachea, air sacs, liver, and intestine and may occasionally be present on brain. Button like structures may be seen on heart. In ocular form eyes become inflamed and large cheesy plaques may found under eye lids. Candidiasis is also fungal infection caused by *candida miniliformis*. *Candida miniliformis* affects the mucus of mouth and esophagus which may cause loss of appetite, dehydration and high mortality.

Prevention and Treatment of Fungal Infections

- Fumigate the hatchery with formaldehyde or Thiabendazole 120-360 g/m^3
- Avoid use of moldy litter and feed
- Spray shed with 1% $CuSO_4$ solution
- Wash all equipments with1% $CuSO_4$ solution
- Use toxin binder in feed
- Provide solution of $CuSO_4$ (1gm $CuSO_4$ per 2 liter of water) to birds
- There is no effective treatment for Aspergillosis however ketoconazole, Clotrimazole, Miconazole, Fluconazole and Amphotercin, Nystain and Itraconazole have found to be effective prevention of the disease
- Frequently change of litter (hay or sand).

Nutritional Deficiency Disorders

Vitamin A, E and selenium deficiencies can produce serious conditions. Prolonged deficiency of vitamin E may cause degeneration of testes in males. Deficiency of vitamin E in chicks may cause severe conditions like Xudative diathesis, muscular dystrophy, Encephalomalecia, swollen hock conditions.

- Parsley (Petroselinumsativum) -induced photosensitivity in captive ostrich.
- Anasarca and myopathy in ostrich chicks.

Treatment

Provide mineral and vitamin supplements 1200IU/Kg diet Vitamin D_2 1000IU/Kg however do not use vitamin D_3 in ostrich

VI. Future Work and Recommendations

Ostrich production can open new vistas for development of healthy beef industry in Pakistan. It is a new value added emergent in live stock production therefore there is paucity of information regarding the pathogenity of this species. Substantial scientific knowledge in most cases of ostrich diseases is shortened especially the details on technical part of diagnostic/screening tests is completely absent. Whereas most standard diagnostic tests (HI, ELISAs tests) used in the poultry are not proved in ostriches. Even in the case of PCR-based test significant ambiguities are found. Therefore, deep scientific research is needed regarding the welfare, immunology and health of ostriches in Pakistan (Abbas *et al.* 2018).

Academia (Riphah College of Veterinary Sciences Lahore, PMAS Arid Agriculture University Rawalpindi and University of Veterinary Sciences Lahore) is playing significant role about the awareness of biosecurity and health concerns of ostrich farming in the country. The support of Government of Pakistan in raising/expanding the funds for research regarding health concerns (biosecurity, vaccination, diagnosis and medication) of ostriches is strongly needed. For this a reliable framework may be formed which will must be supervised by veterinary universities.

References

[1] Abbas, G., M. Z. Rehman, A. Ali, M. Fiaz and A. Mahfooz. 2016. Effect of Use of Different Anthelmintics (Piperazine Citrate and Ivermectine) on Blood Profile of Infested Poultry (Commercial and Rural Layers). Advances in Zoology and Botany 4(1): 1-5.

[2] Abbas, G., S. Mahmood2, M. Sajid and Y. Ali. 2017. Ostrich Farming: A New Turn in Poultry Industry of Pakistan. Advances in Zoology and Botany 5(3): 33-38.

[3] Aganga, A. A., Aganga, A. O., and U. J. Omphile. 2003. Ostrich

Feeding and Nutrition. Pakistan J. Nutr. 2(2), 60-67.
[4] Alexander, D. J. 1995. - The epidemiology and control of avian influenza and Newcastle disease. J. *comp.* Pathol., 112, 105-126.
[5] Alexander, D. J.1982. - Ecological aspects of influenza A virus in animals and their relationship to human influenza: a review. J. roy. *Soc. Med., 75,* 799-811.
[6] Allwright, D. M. 1992. Ostrich influenza - an update, In Proc. South African Veterinary Association Biennial National Congress, 7-10 September, Pretoria. South African Veterinary Association, Pretoria, 159-161.
[7] Allwright, D. M. 1996. Viruses encountered in intensively reared ostriches in southern Africa. *In* Proc, International Conference: improving our understanding of ratites in a farming environment, 27-29 March, University of Manchester, United Kingdom, D.C. Deeming, Hangland Farm Ostriches Ltd, Banbury, 27-33.
[8] Allwright, D.M., Burger W. P., Geyer A. and A. W. Terblanche. 1993. Isolation of an influenza A virus from ostriches (Struthiocamelus). Avian Pathol., 22, 59-65.
[9] Allwright, D. 1996. Viruses encountered in intensively reared ostriches in southern Africa. Proceedings of Improving our Understanding of Ratites in a Farming Environment (pp. 27–33). Oxford, UK.
[10] Anjum, M. S. 2000. Productive performance and physiological behavior of White Leghorn caged layers under different heat combating practices during summer. PhD. Thesis, Department of Poultry Science. University of Agriculture, Faisalabad.
[11] Anon. 1991. Volstruisekrygriep. Agric. *News,* **8,** 8.
[12] Anon. 1994. Influenza in ostriches a cause for concern. Agric. News, **3,** 3.
[13] Anon.1994. Monthly reports. January, February. Directorate of Animal Health, Department of Agriculture, Republic of South Africa, Pretoria
[14] Ashash, E., M. Malkinson, R. Meir and Y. Weisman.1994. Serum therapy of Borna disease in ostriches. *Vet. Rec.,* **135,**
[15] Ashash, E., M. Malkinson, R. Meir, S. Perl and Y. Weisman. 1996. Causes of losses including Borna disease paralytic syndrome affecting young ostriches of one breeding organisation over a five year period (1989-1993). *Avian* Dis., **40,** 240-245.
[16] Ashash, E., Weisman Y., Malkinson M., Perl S. and Mechany S. 1995. Borna disease of ostriches. In Proc. 3rd Conference of the European Community Association of Avian Veterinarians, March, Jerusalem. Isr. *J. vet. Med.,* **51** (314), 149-150.
[17] Bala A.Y., Anka S.A., Waziri A. and H. Shehu.2011. Preliminary survey of ectoparasites infesting chickens (Gallusdomesticus) in our areas of Sokoto Metropolis, Nigerian Journal of Basic and Applied Sciences, 19(2).
[18] Barrow P.A. (1993). - *Salmonella* control past, present and future. Avian *Pathol,* **22,** 651-669.
[19] Becht Hand Richt JA. Borna disease. In: Studdert MJ, editor. Virus diseases of equines. Amsterdam: Elsevier Science Publishers BV; 1996. p. 235-44.
[20] Bertram, B.C.R. 1992. *The ostrich communal nesting system*. Princeton, NJ, USA, Princeton University Press.
[21] Bibi, F., A. B. Shabel, B. P. Kraatz, and A. Thomas. Stidham. 2006. New fossil ratite (Aves: Palaeognathae) eggshell. Discoveries from the Late Miocene Baynunah Formation of the United Arab Emirates, Arabian Peninsula. *Society of Vertebrate Paleontology* 9(1): 2A. Retrieved December 2, 2007.
[22] Blood D.C. and O. M. Radostis 1989). - Diseases caused by Bacillus spp. *In* Veterinary medicine. A textbook of the diseases of cattle, sheep, pigs, goats and horses, 7th Ed. Baillière-Tindall, London, 592-596.
[23] Bolte, A.L., Voelckel, K. &Kaleta, E.F. (1999). Zur Schutzimpfung des Strausses (Struthiocamelus, Linne, 1758) gegen die Newcastle - Krnkheit: Nachweis von Impfstoff - Vertraglichkeitun Serokonversion post vaccinationemmittels HAH- und VN-Test. Deutsche tierarztliche Wochenschrift, 106, 53– 84.
[24] Brown T.P., Roberts W. & Page R.K. (1993). – Acute haemorrhagicenterocolitis in ratites: isolation of eastern equine encephalomyelitis virus and reproduction of the disease in ostriches and turkey poults. Avian Dis., 37, 602-605.
[25] Brown, A. C. 2015. Understanding foods: principles and preparation. 5th Edition, 200 first stamford Place, 4th floor Stamford, CT 06902, USA. pp 257.
[26] Brown, C. R., Peinke, D. and loveridge, A. (1996) Mortality in near-term ostrich embryos during artificial incubation. British Poultry Science, 37: 73–85.
[27] Burger W.P. (1992). - Virussiekte in volstruiseontdek. *VetNuus,* March, 15.
[28] Burt, F.J., R. Swanepoel, and L. E. O. Braack. 1993. Enzyme-linked immunosorbent assays for the detection of antibody to Crimean-Congo haemorrhagic fever vims in the sera of livestock and wild vertebrates. Epidemiol. *Infect.,* **111,** 547-557.
[29] Cadman, H.F., Kelly P.J., De Angelis N.D., Rohde C, Collins N. and T. Zulu. 1997. Comparison of enzyme-linked immunosorbent assay and haemagglutination inhibition test for the detection of antibodies against Newcastle disease vims in ostriches (Struthiocamelus). Avian Pathol, 26, 357-363.
[30] Capua, I. 1998. Crimean-Congo Haemorrhagic Fever in ostriches: a public health risk for countries of the European Union? Avian *Pathol,* 27, 117-120.
[31] Capua, I.; Mutinelli, F.; Bozza, M.A.; Terregino, C. and G. Cattoli. 2000. Highly pathogenic avian influenza (H7N1), in ostriches (Struthiocamelus). Avian Pathology, 29 (6): 643 – 646.
[32] Coetzer J.A.W., Thomson G.R. & Tustin R.C. 1994. Infectious diseases of livestock with special reference to southern Africa, Vol. 1. Oxford University Press, Cape Town, 663-670.
[33] Cooper, J. C. 1992. *Symbolic and Mythological Animals.* Kent, UK: Aquarian Press. ISBN 1855381184.
[34] Cooper, R. G., and J. O. Horbanczuk (2004). Ostrich nutrition: a review from a Zimbabwean Perspective. Rev. Sci. Tech. Off. Int. Epiz. 23(3), 1033-1042
[35] Corrado A. 1966. Studio di unceppo di virus dellamalattia di Newcastle isolatodallostruzzo *(Struthiocamelus).* Zooprofilassi, 21, 573-597.
[36] Cox, C. R. and B. J. Leboeuf. 1977. Fe male inritation of male competition: amrchanism of mate sclrrtioii American Naturalist, 111: 317-335.
[37] Crowley, T. J. 1995. "Ice age terrestrial carbon changes revisited". Global Biogeochemical Cycles. 9 (3): 377–389.
[38] DEEMING D.C. (1999): The Ostrich - Biology, Production and Health. 1st edition, CABI Publishing, London, 358 p.
[39] Deeming, D.C. (1999). The Ostrich biology, production and health. USA and UK: CAB Publishing, 1-9.
[40] Deeming, DC & Ar, A 1999, Factors affecting the success of commercial incubation, in: Deeming, D.C. (Ed) The Ostrich; Biology, Production and Health, pp. 159-190 (Wallingford, CAB International)
[41] Degen, A.A., Kam, M. & Rosenstrauch, A. 1989. Time-activity budget of ostriches (*Struthiocamelus*) offered concentrate feed and maintained in outdoor pens. *Appl. Anim. Behaviour*, 22: 347-358.
[42] DINGLE J. and M. M. Shanawany 1999. Ostrich Production Systems: FAO Animal Production and Health Paper 144. 1st edition, FAO, Rome, 256 p
[43] Donegan, K. 2002. *Struthiocamelus*. Animal Diversity Web, University of Michigan Museum of *Zoology*. Retrieved December 2, 2007.
[44] Doosti, A., P. G. Dehkordi and H. K. Bakhsh. 2012. cDNA cloning and sequencing of ostrich growth hormone. Arch. Biol. Sci., Belgrade, 64 (2), 445-449.
[45] Eckroade R.J., Silverman L.A. & Acland H.M. (1984). – Avian influenza in Pennsylvania. *In* Proc. 33rd Western Poultry Disease Conference, 27-29 February, Davis, California. University of California, Davis, 1-2.
[46] Eckroade R.J., Silverman L.A. and H. M. Acland. 1984. Avian influenza in Pennsylvania. *In* Proc. 33rd Western Poultry Disease Conference, 27-29 February, Davis, California. University of California, Davis, 1-2.
[47] Fleming, J. 1822. *The Philosophy of Zoology.* Edinburgh, UK: A. Constable.
[48] Frank R. K. and Carpenter J. 1992. Coronaviral enteritis in an ostrich (Struthiocamelus) chick. J. Zoo Wildl. Med., 23, 103-107.
[49] Gill, G. 2010. How ostriches run faster than us. Science and nature reporter, BBC News Page last updated at 08:00 GMT, Thursday, 28 October 2010 09:00 UK.
[50] Gilman, D. C., H. T. Peck, and F. M. Colby. 1903. *The New International Encyclopædia.* New York, NY: Dodd, Mead and Company.
[51] Gough R.E., Drury E., Cox W.J., Johnson C.T. andA. E.

Courtenay 1998. Isolation and identification of birnaviruses from ostriches. *Vet. Rec.,* 142, 115-116.

[52] Harper, D. 2001. Ostrich. *Online Etymology Dictionary*. Retrieved December 2, 2007.

[53] Hassan, S. M., Siam, A. A., Mady, M. E., and A. L. Cartwright (2004). Incubation temperature for ostrich (Struthiocamelus) eggs. Poult. Sci. 83, 495-499.

[54] Heckert R.A., Mclsacc M., Chan M. &Zhon E.-M. (1999). - Experimental infection of emus *(Dromaius novaehollandiae)* with avian influenza viruses of varying virulence: clinical signs, virus shedding and serology. Avian *Pathol,* 28, 13-16.

[55] Hoogstraal H, 1979. The epidemiology of Crimean- Congo haemorrhagic fever in Asia, Europe and Africa. J. *Med.* Entomol., 15, 307-417.

[56] Hoogstraal H. 1979. The epidemiology of Crimean-Congo haemorrhagic fever in Asia, Europe and Africa. J. *Med.* Entomol., 15, 307-417.

[57] Hoogstraal H., Kaiser M.N., Traylor M.A., GaberS. &Guindy E. 1961. Ticks (Ixodidea) on birds migrating from Africa to Europe and Asia. Bull, *WHO,* 24,197-212.

[58] Hoogstrall H., Kaiser M.N., Traylor M.A., Guindy E. & Gaber S. 1963. - Ticks *(Ixodidea)* on birds migrating from Europe and Asia to Africa. Bull. WHO, **28,** 235-262.

[59] Huchzermeyer F.W. & Gerdes G.H. 1993. Newcastle disease virus isolated from ostriches in South Africa. J. S. *Afr.* vet. Assoc., 64, 140.

[60] Huchzermeyer F.W. (1996). - Velogenic Newcastle disease in ostriches in South Africa. In Proc. International Conference: improving our understanding of ratites in a farming environment, 27-29 March, University of Manchester, United Kingdom. D.C. Deeming, Hangland Farm Ostriches Ltd, Banbury, 44 pp.

[61] Huchzermeyer F.W. 1997. Animal health risks associated with ostrich products. *In* Contamination of animal products: prevention and risks for animal health (P. Sutmoller, ed.). Rev. sci. *tech. Off. int. Epiz.,* 16 (1), 111-116.

[62] Huchzermeyer F. W. 1997b. - Public health risks of ostrich and crocodile meat. *In* Contamination of animal products: prevention and risks for public health (A.S. Ahl & P. Sutmoller, eds). Rev. sci. *tech. Off. int. Epiz.,* 16 (2),599-604.

[63] Huchzermeyer F.W. 1998. Diseases of ostriches and other ratites. Agricultural Research Council, Pretoria, South Africa, 304 pp.

[64] Huchzermeyer F W. 1996. Newcastle Disease in ostriches in South Africa. Proc. Improving our understanding of rataties in a farming environment. Ed. Deeming DC, Manchester, England, pp 55–66

[65] Jensen J.M., Johnson J.H. & Weiner S.T. 1992. Husbandry and medical management of ostriches, emus and rheas. Wildlife and Exotic Animal Teleconsultants, College Station, Texas.

[66] Jordan F.T.W. & Pattison M. (1996). - Poultry diseases, 4th Ed. W.B. Saunders Company Ltd, London, 497 pp.

[67] Kaplan M.M. & Webster R.G. (1977). -The epidemiology of influenza. Sci. Am., 237, 88-106.

[68] Karklina, D., Kivite, J., Dukalska, L., Skudra, L., Sturmovica, E., Kruma, Z., Murniece, I., Galoburda, R., and M. Sabovics. 2008. Overview of ready to-eat ostrich meat preparation method without decomposition of constituents. Foodbalt. 74-78.

[69] Kauker E. and Siegert R. (957. Newcastle virus-Infektionbeimafrikanischen Strauss (Struthiocamelus L.), Zwerggänsegeier (Pseudo gyps *africanus* Salvad.) und Bunttukan (Ramphastosdicoloras L.). Monatsh. Tierheilkd., 9, 64-68.

[70] Kennedy M. &Brenneman K. (1995). - Enteritis associated with a coronavirus-like agent in a rhea *(Rhea americana)* chick. J. avian Med. *Surg., 9,* 138-140.

[71] Kirkwood J.K. & Cunningham A.A. 1994. Epidemiological observations on spongiform ncephalopathies in captive wild animals in the British sles.Vet. Rec., 135 (13), 296-303.

[72] Klöppel G. (1963). - Newcastle-Infektionenbei Straussen. leintíerpraxis, **8,** 10-12.

[73] Komano, T., Takebe, S., Taguchi, Y., and H. Sakai 1999. Cloning and sequencing of cDNA that encode Ostrich growth hormone. Mem. School. B.O.S.T. Kinki University. 5, 74-81.

[74] Lambrechts, H., Huchzermeyer, F.W. and Swart, D. (1998). Integrating Ostrich Behaviour in Commercial Farming Systems. Paper presented at the 2nd International Scientific Ratite Congress, Oudtshoorn, South Africa. October 1998.

[75] Lombardo, E., A. Maraver, I. Espinosa, A. Fernandez-Arias, and J. Rodriguez. VP5, the nonstructural polypeptide of infectious bursal disease virus, accumulates within the host plasma membrane and induces cell lysis. Virology 277:345-357. 2000.

[76] Malecki, IA and Martin, GB 2002a, Fertile period and clutch size in the Emu (Dromaius novaehollandiae) Emu 102, 1-6.

[77] Malecki, IA, Cloete, SWP, Gertenbach, WD & Martin, GB 2004, Sperm storage and duration of fertility in female ostriches (Struthiocamelus). South African Journal of Animal Science, 34: 158-165.

[78] Malkinson M, Weisman Y, Perl S, Asash EA. Borna-like disease of ostriches in Israel. Borna Disease. Curr Top MicrobiolImmunol. 1995; 190: 31–8.

[79] Marx (1900). – Uebereineinfektiöse Krankheit der Straussen. *Zentralbl. Bakteriol,* 27, 822-824. 100 Okoh A.E.J. (1980). - An outbreak of pasteurellosis in Kan Zoo. J. Wildl. Dis., 16, 3-5.

[80] McFerran, J. B., M. S. McNulty, F. R. McKillop, T. J. Connor, R. M. McCracken, D. S. Collins, and G. M. Allan. Isolation and serological studies with infectious bursal disease viruses from fowl, turkeys and ducks - demonstration of a 2nd serotype. Avian Pathol. 9:395-404. 1980.

[81] Mostafavi E., Chinikar S., Moradi M., Bayat N., Meshkat M., Fard M.K. and Ghiasi S.M. 2013. A case report of crimeancongo hemorrhagic Fever in ostriches in iran, The open virology journal, 7, Pesenti 81.

[82] Nell, L. 2003. *The Garden Route and Little Karoo.* Cape Town, ZA: Struik Publishers. ISBN 1868728560.

[83] Nemejc, K. and D. Lukesova. 2012. Parasite Fauna of Ostriches, Emus and Rheas. Agricultura Tropicaet Subtropica. 45(1): 45-50.

[84] Office International des Epizooties (OIE) (1996). – Manual of standards for **diagnostic** tests and vaccines, 3rd Ed. OIE, Paris, 723 pp.

[85] Oyarzabal O.A., Conner D.E. & Hoerr F.J. 1995. -Incidence of Campylobacters in the intestine of avian species in Alabama. Avian Dis., 39, 147-151.

[86] Peccati C, Grilli G., Gallazzi D. & Rampin T. 1996. Serological survey in ostriches in northern Italy. In Proc. International Conference: improving our understanding of ratites in a farming environment, 27-29 March, University of Manchester, United Kingdom. D.C. Deeming, Hangland Farm Ostriches Ltd, Banbury, 47 pp.

[87] Perelman B. 1993. - Medical problems observed in ostriches raised under intensive conditions. In Proc. Ostriches (ratites), 2 March, Slagharen, the Netherlands.

[88] Perelman B., Greiff M., Kuttin E.S. &Rogol M. 1992. Campylobacteriosis in ostriches. Isr. J. *vet. Med.,* 47,116-119.

[89] Pesenti, T.C., Gallina T., Langone P.Q., Silva M.A.M.P., Suárez A.G.R., Silva D.S. and Müller G. 2015. Nematode infection in Struthiocamelus (Linnaeus, 1758) (ostrich) in Southern Brazil, Science and Animal Health, 3 (1), 103-112.

[90] Placidi L. & Santucci J. (1954). – Observation épidémiologiquesur la maladie de Newcastle. Evolution de l'infection dans un parc zoologique. *Bull. Acad. vét. Fr.,* 27, 255-258.

[91] Placidi L. & Santucci J. (1954). – Observation épidémiologiquesur la maladie de Newcastle. Evolution de l'infection dans un parc zoologique. *Bull. Acad. vét. Fr.,* 27, 255-258.

[92] Regnault S, Allen VR, Chadwick KP, Hutchinson JR. 2017.Analysis of the moment arms and kinematics of ostrich (*Struthiocamelus*) double patellar sesamoids. J. Exp. Zool.1–9.

[93] Richt JA, VandeWoude S, Zink MC, Clements JE, Herzog S, Stit z L, Infection with Borna disease virus: molecular and immunobiological characterization of the agent. Clin Infect Dis. 1992; 14: 1240–50.

[94] Robertson W. (1908). - Case of anthrax in an ostrich. J. *comp. Pathol,* 21, 261-262.

[95] Roots, C. 2006. *Flightless Birds.* Westport CT: Greenwood Press. ISBN 0313335451.

[96] Rott Rand Becht H. Natural and experimental Borna disease in animals. Borna disease. Curr Top MicrobiolImmunol. 1995; 190: 17–30.

[97] Sadiq, N. 2015. The Policy Papers Government of the Punjab Livestock & Dairy Development Department. Accessed at http://www.livestockpunjab.gov.pk/assets/policy/Punjab%20Livestock%20Policy%20_%2016.6.2015.pdf.

[98] Samberg V., Hadash D.V., Perelman B. &Meroz M. (1989).

Newcastle disease in ostriches (Struthiocamelus); field case and experimental infection. Avian Pathol., 18, 221-226.

[99] Samberg Y, Hadash DU, Perelman B, Meroz M (1989) Newcastle disease in ostriches (Struthiocamelus): field case and experimental infection. Avian Pathology 18:221–226

[100] Sauer, E.G.F. 1966. Social behaviour of the South African ostrich (*Struthiocamelusaustralis*). Ostrich, 6: 183-191.

[101] Schachter J. 1989. - Chlamydial infections-past, present, future. JAVMA, 195 (11), 1501-1506.

[102] Schoon H.A., Brunckhorst D. &Pohlens J. 1991. Spongiform encephalopathy ta an ostrich (Struthiocamelus). A case report. *Tierärzti* Praxis, 19 **(3),** 283-265.

[103] Scott, T. A. 1996. *Concise Encyclopedia Biology.* Berlin, DE: Walter de Gruyter. ISBN 3110106612.

[104] Shepherd A.J., Swanepoel R., Leman P.A. & Shepherd S.P. 1987.Field and laboratory investigation of Crimean-Congo haemorrhagic fever vims *(Nairovirus,* family Bunyaviridae) infection in birds. Trans. roy. Soc. trop. Med. *Hyg.,* 81, 1004-1007.

[105] Shivaprasad H. L. 1993. - Neonatal mortality in ostriches: an overview of possible causes, In Proc. Association of Avian Veterinarians (AAV), 31 August-4 September, Nashville, Tennessee. AAV, Boca Raton, Florida, 282-293.

[106] Smith C. A. 1993. - Ostrich chick survival presents a challenge. J. Am. *vet. med. Assoc.,* 203, 637-643.

[107] Stallknecht D.E. & Shane S.M. 1988. - Host range of avian influenza vims in free-living birds. *Vet. Res. Commun.,* 12,125-141.

[108] Stornelli, M. R., Ricciardi, M. P., Giannessi, E., and A.Coli (2006). Morphological and histological study of the ostrich (Struthiocamelus L.) liver and biliary system. It. J. Anat. Embryol. 111(1), 1-7.

[109] Subbarao K., Klimov A. and Katz J. 1998. – Characterization of an avian influenza A (H5N1) virus isolated from a child with a fatal respiratory illness. *Science,* 279, 393-396.

[110] Swanepoel R. 1994. - Crimean-Congo haemorrhagic fever. In Infectious diseases of livestock with special reference to southern Africa, Vol. 1 (J.A.W. Coetzer, G.R. Thomson & R.C. Tustin, eds). Oxford University Press, Cape Town, 723-729.

[111] Swanepoel R. 1994. Crimean-Congo haemorrhagic fever. In Infectious diseases of livestock with special reference to southern Africa, Vol. 1 (J.A.W. Coetzer, G.R. Thomson & R.C. Tustin, eds). Oxford University Press, Cape Town, 723-729.

[112] Swanepoel R., Leman P.A., Burt F.J., Jardine J., Verwoerd D.J., Capua I., Brükner G.K. & Burger W.P. 1998. Experimental infection of ostriches with Crimean-Congo haemorrhagic fever virus. *Epidemiol. Infect.,* 121, 427-432.

[113] Swanepoel R., Shephard A.J., Leman P.A., Shephard S.P. & Millar C.B. (1985). - A common-source outbreak of Crimean-Congo haemorrhagic fever on a dairy farm. S. *Afr. med. J.,* 68, 635-637.

[114] Theiler A. (1912). - Anthrax in the ostrich. *Agric J. Union S. Afr.,* 4, 370-379.

[115] Thomson G.R. (1994). - Equine encephalitides caused by alphavirus. In Infectious diseases of livestock with special reference to southern Africa, Vol. 1 (JAW. Coetzer, G.R. Thomson & R.C. Tustin, eds). Oxford University Press, Cape Town, 636-641.

[116] Tully T.N. &Shane S.M. (eds) 1996. Ratite management, medicine and surgery. Krieger, Malabar, Florida, 188 pp.

[117] Tully T.N. & Shane S.M. 1996. Ratite management, medicine and surgery. Krieger, Malabar, Florida, 188 pp.

[118] Van Riper C. and Forrester D.J. 2007. Avian pox, Infectious diseases of wild birds , 131-176

[119] Van Nieker D. J., Fourie L.J. and Horak I.G.2006. Birds as hosts of immature ixodid ticks in Free State Province, South Africa Onderstepoort Journal of Veterinary Research,73 (2)

[120] Van Schalkwyk, S.J., Cloete, S.W. P., Brown, C.R. and brand, Z. 2000. Hatching success of ostrich eggs in relation to setting, turning and angle of rotation. British Poultry Science, 41: 46–52.

[121] Vanhooser S.L. & Welsh R.D. 1995. - Isolation of Salmonella species from ratites. J. vet. diagn. Invest, 7, 268-269.

[122] Verwoerd D.J. 1995. Velogenic Newcastle disease epidemic in South Africa. II. Ostriches, waterfowl, exotic bird collection and wild birds. S. *Afr. Vet. Med.,* **8,** 44-49.

[123] Verwoerd D.J., Olivier A.J., Henton M.M. & Van Der Walt M. (1998). - Maintaining health and performance in the young ostrich: applications for a mannan oligosaccharide. In Proc. Alltech 14th Annual Symposium: passport to the year 2000 (T.P. Lyons &K.A. Jacques, eds), April, Lexington, Kentucky. Nottingham University Press, Nottingham, 539-552.

[124] Verwoerd DJ 1995 Velogenic Newcastle disease epidemic in South Africa. Part II: ostriches, waterfowl, exotic bird collections and wild birds. S Af Vet Med 8:44–49.

[125] Verwoerd, D.J., Gerdes, G.H., Olivier, A. & Williams, R. (1997). Experimental infection of vaccinated slaughter ostriches with virulent Newcastle disease virus. Onderstepoort Journal of Veterinary Research, 64, 213–2.

[126] Villareal-Ch C.L. & Flores H.A.O. 1998. The Mexican avian influenza H5N2 outbreak. In Proc. 4th International Symposium on avian influenza (D.E. Swayne & R.D. Slemons, eds), 29-31 May 1997, Athens, Georgia. United States Animal Health Association, Richmond, Virginia, 18-22.

[127] Villareal-Ch C.L. & Flores H.A.O. 1998. The Mexican avian influenza H5N2 outbreak. In Proc. 4th International Symposium on avian influenza (D.E. Swayne & R.D. Slemons, eds), 29-31 May 1997, Athens, Georgia. United States Animal Health Association, Richmond, Virginia, 18-22.

[128] Vorster J.H. & Olivier A.J. 1998. Diseases affecting the central nervous system of ostriches in southern Africa. In Proc. 2nd International Ratite Symposium: ratites in a competitive world (F.W. Huchzermeyer, H. Lambrechts, D. wart, S.W.P. Cloete, T.S. Brand & D.J. Verwoerd, eds), 21-25 September, Oudtshoorn, South Africa. Department of Agriculture, Western Cape Province, Elsenburg, Stellenbosch, 201-204.

[129] Wells G.A.H., Scott A.C., Wile smith J.W., Simmons M.M. &Matthews D. 1994. Correlation between the results of a histopathological examination and the detection of abnormal brain fibrils in the diagnosis of bovine spongiform encephalopathy. Res. vet. Sci., 56 (3), 346-351.