THE NEED FOR A HOLISTIC VIEW ON DISEASE PROBLEMS IN FREE-RANGE CHICKENS

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Abstract

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In contrast to modern poultry production, village-based poultry production is often characterised by a range of diseases occurring at the same time. Most often free-range poultry have sub-clinical infections with a high number of endo- and ecto-parasites. The significance of these infections is not known in detail, but there are some indications that parasites have an immuno-suppressive effect on the animals thus enhancing the pathogenicity of other diseases. Further, it is postulated that other diseases than Newcastle disease (ND) are present in free-range poultry production systems and that a successful development of this production system is only achieved when the exact causes of death and the effect of concurrent diseases are known.

1. INTRODUCTION

Poultry production has undergone rapid changes during the past decades due to the introduction of modern intensive production methods, new breeds, improved bio-security and preventive health measures. Modern production places high demands on proper health, hygiene and management and requires only a small, but very skilled labour force.

In developing countries, however, adoption of this type of production has been limited due to the need for high inputs. The progress in industrial poultry production methods has thus had little effect on subsistence poultry production in the rural and peri-urban areas. In these areas access to poultry meat and eggs depends on village-level poultry production. Although poultry production is considered as secondary to other agricultural production systems it has an important role in supplying villagers with additional income and high quality protein. This system provides valuable protein through a low input system, now representing 30% or more of all protein consumed [1].

Almost all families in developing countries keep a small chicken flock off 5–20 adult chickens. The majority of these animals are kept in free-range scavenging systems, where the birds scavenge around the house during daytime. Primitive housing of the birds during the night often takes place. Supplementary feed consists mainly of household wastes, insects, larvae and seeds [2, 3, 4, 5].

In Nigeria and Mali mortalities have been observed to be 80–90% within the first year after hatching [6, 7]. The majority of the mortality takes place within the first 3–4 months after hatching. For the same reasons the owners never include chicks when they refer to the flock size. The mortality is believed to be caused by diseases, predators, lack of supplementary feed, suboptimal management including lack of good advisors [2, 3, 8, 9].

Little research has been published on rural poultry health, despite the fact that up to 80% of the poultry population in Africa and Asia is kept by the households as free-range chickens [3, 5]. Although solid data have not been published, Newcastle Disease (ND) is regarded as the principle factor limiting rural poultry production in all African and Asian countries. ND may kill up to 80% of household poultry in Africa [3, 5, 10, 11], but is not expected to account for the high early mortality rate according to the authors. In addition, detailed epidemiology of the disease in the village situation is largely unknown [12]. Furthermore, recent studies have shown that other diseases are present in scavenging poultry communities [11, 13, 14, 15, 16, 17, 18].

Since most of our knowledge relies on serological prevalence studies, solid longitudinal studies on causes of mortality are strongly needed to improve our knowledge on the prevalence and significance of the single diseases under village conditions. Furthermore, the biosecurity level in village production systems is low leading to multiple infections at the same time. Few studies have been carried out with this aspect in mind.

2. DISEASES

The following data reflect experience obtained under backyard conditions in developed countries combined with knowledge from commercial production systems.

According to Jordan and Pattison [19] and Calnek *et al*. [20] poultry diseases can be divided into five groups, namely bacterial (Table I), viral (Table II), fungal (Table III), parasitic (Table IV) and nutritional (Table V) diseases. Only the diseases of importance under village conditions, e.g. those causing high mortality rates in chickens are mentioned in the Tables.

TABLE I. IMPORTANT BACTERIAL DISEASES IN FREE-RANGE POULTRY AND THE AGE GROUP IN WHICH THE DISEASE IS MOST OFTEN OBSERVED

Disease agent	Age group
Escherichia coli	all ages, but mainly chicks
Salmonella spp.	all ages, but mainly chicks
Salmonella pullorum	chicks < 3 weeks
Salmonella gallinarum	growers, adults
Pasteurella multocida	growers, adults
Haemophilus paragallinarum (Coryza)	growers, adults
Clostridium perfringens	all ages, but mainly growers
Mycobacterium avium	adults
Mycoplasma gallisepticum	all ages
Mycoplasma synoviae	all ages

TABLE II. IMPORTANT VIRAL DISEASES IN FREE-RANGE POULTRY AND THE AGE GROUP IN WHICH THE DISEASE IS MOST OFTEN OBSERVED

Disease agent	Age group
Mareks disease*	> 6 weeks
Leucoses*	Adults
Newcastle disease	Mainly growers and adults
Fowl Pox	all ages
Infectious Laryngotracheitis	growers, adults
Infectious Bursal disease (Gumboro)*	< 8 weeks

*immunosuppressive disease

TABLE III. IMPORTANT FUNGAL DISEASES IN FREE-RANGE POULTRY AND THE AGE GROUP IN WHICH THE DISEASE IS MOST OFTEN OBSERVED

Disease agent	Age group
Aspergilloses	Chicks
Mycotoxicoses	all ages

TABLE IV. IMPORTANT PARASITIC DISEASES IN FREE-RANGE POULTRY AND THE AGE GROUP IN WHICH THE DISEASE IS MOST OFTEN OBSERVED

Disease agent	Age group
Coccidiosis	chicks, growers, (adults)
Histomoniasis	1–3 months
Nematodes	all ages
Haemoparasites	chicks, growers
Ectoparasites	Mainly chicks & growers, but also adults

TABLE V. IMPORTANT NUTRITIONAL DISEASES IN FREE-RANGE POULTRY AND THE AGE GROUP IN WHICH THE DISEASE IS MOST OFTEN OBSERVED

Disease agent	Age group
Vitamin A, D & E	chicks, growers
Other vitamins, minerals and amino acids	chicks, growers

As seen, a wide variety of diseases is expected to occur under village conditions. Some of these diseases are age-specific, whereas others are encountered in all age groups.

3. DISCUSSION

Approximately 80% of the world poultry population is kept as free-range poultry [1, 5]. The free-range poultry production system has also been designated as a “low input-low output” system [2]. Mortality rates have been in the range of 80–90% within the first year after hatching in Nigeria and Mali and is thought to be equally high in other tropical countries as well [6, 7]. The high mortality is believed to be caused by mismanagement, lack of fresh water and supplementary feed, predators and diseases [2, 3]. Of these, diseases are believed to be the main limiting factor to the production of indigenous chickens [3]. Among causes of early mortality nutritional diseases might be expected to dominate due to shortage of supplementary feed before and after hatch. In addition, the quality of hatching eggs might be questioned under the climatic conditions present in these countries. Avitaminoses and lack of protein weaken the chicks and make them vulnerable to other diseases and predators. Diseases are also easily contracted under free-range conditions due to scavenging habits [2, 21]. With an unconfined type of management, disease control is very difficult to carry out and is therefore rarely practised by the owners.

As mentioned earlier, Newcastle Disease is believed to be the most important disease in free-range systems [3, 5, 11]. During outbreaks of the disease up to 80% of the population may die. This, however, is dependant on different factors including the virulence of the strain causing the outbreak [10]. A recent study in Nicaragua [22] has, however, shown that in ND-immunised birds mortality is still high. The majority of the mortality is found in chicks up to 3-4 months of age. In this group up to 52.5% of the animals died due to other causes than ND. Similar studies in Mali by Wilson *et al*. [6] have shown that chick mortality is in the range of 60% within the first 3 months after hatching.

A study in Morocco [23] has revealed that up to 58% of the village chickens had antibodies against *Salmonella gallinarum* and *S. pullorum*. Similar findings were reported by Adesiyun *et al*. [24] from Nigeria. Chrysostome and his coworkers [16] reported that 10% of the village chickens had antibodies against *S. pullorum* and that 62% had antibodies against *Mycoplasma gallisepticum*. Furthermore, 65% of the animals had antibodies against ND. In Mauritania, Bell *et al*. [18] found that 17.5% of the birds had antibodies against *S. pullorum* and that up to 46.2% of the birds had antibodies against Gumboro disease. In the same animals 7.5% had antibodies against ND. In Tanzania, Permin *et al*. [25, 27] examined 600 live chickens and found the presence of a range of diseases. All animals were parasitised with one or more (up to 14 species) species of endoparasites. In total 29 different species were detected in the study. Furthermore, 65.7% of the animals were parasitised with *Cnemidocoptes mutans*, *Dermanyssus gallinae* and/or *Echidnophaga gallinacea*. The animals were also infected with a range of haemoparasites, the most common being *Plasmodium juxtanucleare* and *Aegyptinella* spp. Antibodies against Newcastle disease was seen in 7.3% of the animals, against *Salmonella enteriditis* in 2.0%, against *Salmonella gallinarum/pullorum* in 52.7%, against Infectious Laryngotracheitis in 58.3% and against Gumboro disease in 42.3%. Similar studies have to the knowledge of the authors not been carried out in Asian countries. The significance of all these diseases, however, remains to be investigated. In addition, it should be noted here that a general trend for these studies is that they have only looked for antibodies against selected diseases.

With the overall title “Multiple infections in scavenging poultry: Interactions between the host and combined infections caused by virus, helminths and bacteria and their effect on production parameters” a number of studies have been carried out by the main author in collaboration with national and international research partners/institutions. Experimental studies have confirmed our hypothesis that combined infections commonly found in village chickens have an impact not only on morbidity, mortality, and production parameters such as weight gain, point of lay, but also epidemiological factors such as carrier status, i.e. spread of the disease. Investigations on the effect of *Ascaridia galli* on the immune system in chickens has shown that chickens possess an ability to expel worm populations [26]. The effect is probably related to genetic characteristics of the chicken genome [28, 29]. These observations led to further investigations studying the influence of *A. galli* on subsequent *E. coli* infections. A significant impact of the combined infections was seen on weight gain and, furthermore, a trend was seen towards severe pathological changes in group with combined infections [30, 31]. In a similar set-up the effect of *A. galli* on subsequent *Pasteurella multocida* infections was studied [32]. Similarly, the combined infection had a significant effect on weight gain and more important also on mortality. Field studies in Tanzania and Indonesia have partly confirmed the laboratory observations. Specially in Indonesia a trial using village chickens showed that not only did the animals, naturally infected with parasites, become carriers when infected with *Pasteurella multocida* but also that the animals showed a significantly lower sero-conversion when they were vaccinated against Newcastle disease [33]. This indicates that the parasites might have an immunosuppressive effect on the animals, which indirectly leads to the assumption, that vaccines are not protecting the animals after having been applied. These studies, based on clinical observations, epidemiological field data and laboratory confirmation, indicate that interactions between parasitic, bacterial and viral diseases exist and is in accordance with earlier work where it is known that immune-suppressed chickens harbour significantly higher numbers of *A. galli* compared to other chickens [34, 35]. However, our observations have been made under field conditions and will have to be confirmed under controlled laboratory trials. If the observations are reconfirmed under laboratory conditions it will lead to a totally new idea on how to immunise village poultry.

In summary we can conclude that long-term cohort studies, examining the causes of mortality, have to date not been carried out in the free-range production systems. Important knowledge on the proportion of the individual disease of the overall mortality is thus not known. Furthermore, it has been seen, under experimental conditions, that concurrent infections (the most common situation under field conditions) lead to immune suppression, increased pathogenicity of diseases and a prolonged carrier state. It is postulated that other diseases than ND are present in free-range poultry production systems and that a successful development of this production system is only achieved when the exact causes of death and the effect of concurrent diseases are known.

REFERENCES

[1] FAO, FAOSTAT www.fao.org, Statistical database of Food and Agriculture Organization of the United Nations, Rome Italy (2000).

[2] PANDEY, V.S., Epidemiology and economics of village poultry production in Africa: Overview. Conference Proceedings, Village poultry production in Africa, Rabat, Morocco Pandey, V.S. and Demey, F. (Eds) (1992) 124-128.

[3] AINI, I., Indigenous chicken production in South-east Asia, World's Poultry Science J. **46** (1990) 51-57.

[4] KABATANGE, M.A., KATULE, A.M., Rural poultry production systems in Tanzania. Sonaiya, E.B. (Ed.) Rural poultry in Africa. Conference Proceedings, Ile-Ife, Nigeria (1990) 171-176.

[5] MINGA, U.M., KATULE, A.M., MAEDA, T., MUSASA, J., Potential and problems of the traditional chicken industry in Tanzania, Proceedings of the 7th Tanzania veterinary scientific conference, Arusha, (1989) 207-215.

[6] WILSON, R.T., TRAORE, A., KUIT, H.G., SLINGERLAND, M., Livestock production in central Mali: Reproduction, growth and mortality of domestic fowl under traditional management, Trop. Anim. Hlth Prod. **19** (1987) 229-236.

[7] MATTHEWMAN, R.W., A survey of small livestock production at the village level in the derived savanna and lowland forest zones of South West Nigeria, University of Reading. Department of Agriculture and Horticulture. Study No. 24 (1977) 40-41.

[8] BAGUST, T.J., Improving health for poultry production in Asia: a developmental perspective , Avian Pathol **23** (1994) 295-304.

[9] BAGUST, T.J., Improving health for a poultry industry in Asia: a developmental perspective, Avian Pathol. **23** (1994) 395-404.

[10] ALEXANDER, D.J., Newcastle Disease and Other Avian Paramyxoviridae Infections. In: Calnek, B.W., Barnes, H.J. Beard, C.W., McDougald, L.R., Saif Y.M., Diseases of Poultry. Iowa State University Press, Ames, Iowa, (1997) 541-569.

[11] BELL, J.G., The village chicken and disease control, Tanz. Vet. J. **12** (1992) 44-47.

[12] YONGOLO, H.M., Epidemiology of Newcastle disease in village chickens in Tanzania, M.Sc. Thesis, Sokoine University of Agriculture, Morogoro, Tanzania (1997) 234 pp.

[13] PERMIN, A., FADJAR, S., SCHOU, T.W., LARSEN, M., The effect of concurrent infections in village poultry and the effect on Newcastle disease vaccination (in preparation).

[14] ESMANN, J.B., HØJ, C.H., PERMIN, A., MUKURATIRWA, S., Ecto-, endo- and haemoparasites in scavenging chickens in the Goromonzi District, Zimbabwe (in preparation).

[15] POULSEN, J., PERMIN, A., HINDSBO, O., YELIFARI, L., NANSEN, P., BLOCH, P., Prevalence and distribution of gastro-intestinal helminths and haemoparasites in young scavenging chickens in upper eastern region of Ghana, West Africa, Prev. Vet. Med. **45** (2000) 237-245.

[16] CHRYSOSTOME, C.A.A.M., BELL, J.G., DEMEY, F., VERHULST, A., Seroprevalences to three diseases in village chickens in Benin, Prev. Vet. Med. **22** (1995) 257-261.

[17] CUMMING, R.B., Village chicken production: Problems and potential in Newcastle disease in village chickens, ACIAR Proceedings (1992) 189 pp.

[18] BELL, J.G., KANE, M., LE JAN, C., An investigation of the disease status of village poultry in Mauritania, Prev. Vet. Med. **8** (1990) 291-294.

[19] JORDAN, F.T.W., PATTISON, M., Poultry Diseases, W.B. Saunders Company Ltd, London (1996) 546 pp.

[20] CALNEK, B.W., BARNES, H.J., BEARD, C.W., MCDOUGALD, L.R., SAIF, Y.M., Diseases of Poultry, Iowa State University Press, Ames, Iowa, (1997) 1080 pp.

[21] SOULSBY, E.J.L., Helminths, Arthropods and Protozoa of Domesticated Animals, Baillière Tindall, East Sussex (1982) 809 pp.

[22] KYVSGAARD, N., 1999 (personal communication).

[23] BOUZOUBAA, K., LEMAINGUER, K., BELL, J.G., Village chickens as a reservoir of *Salmonella pullorum* and *Salmonella gallinarum* in Morocco, Prev. Vet. Med. **12** (1992) 95-100.

[24] ADESIYUN, A.A., BISHU, G., ADEGBOYE, D.S., ABDU, P.A., Serological survey of *Salmonella pullorum* antibody in chickens around Zaria, Nigeria, Bull. Anim. Hlth Prod. in Africa **32** (1984) 81-85.

[25] PERMIN, A., MAGWISHA, H., KASSUKU, A.A., MINGA, U., JØRGENSEN, P., A survey of the disease status of scavenging poultry in Morogoro Region, Tanzania (in preparation).

[26] PERMIN, A., RANVIG, H., NANSEN, P., Differences in parasite burdens between Danish Landrace chickens and Lohman Brown chickens infected with *Ascaridia galli*. In: Proceedings of the 17th International Conference of the World Association for the Advancement of Veterinary Parasitology. Copenhagen, August 1999. c.6.74

[27] PERMIN, A., MAGWISHA, H., KASSUKU, A.A., NANSEN, P., BISGAARD, M., FRANDSEN, F., GIBBONS, L., A cross-sectional study of helminths in rural scavenging poultry in Tanzania in relation to season and climate, J. Helminthology **71** (1997) 233-240.

[28] BUMSTEAD, N., MILLARD, B.M., BARROW, P.A., COOK, J.K.A., Genetic basis of disease resistance in chickens. In: Owen, J.B. & Axford, R.F.E. (Eds) *Breeding for disease resistance in farm animals*, Commonwealth Agricultural Bureau, Wallingford, England, (1991) 10-23.

[29] SIMONSEN, M., CRONE, M., KOCH, C., HALA, K., The MHC haplotypes of the chicken, Immunogenetics **16** (1982) 313-332.

[30] PERMIN, A., CHRISTENSEN, J.P., BISGAARD, M., The interaction between *Ascaridia galli* and *Escherichia coli* infections in chickens. In: The proceedings of the XXI World Poultry Congress. Montreal, August 2000 (2000a) P17.33.

[31] PERMIN, A., CHRISTENSEN, J.P., BISGAARD, M., The immunosuppressive effect of *Ascaridia galli* on subsequent *Escherichia coli* infections in chickens (in preparation).

[32] PERMIN, A., DAHL, C., CHRISTENSEN, J.P., BISGAARD, M., The interaction between *Ascaridia galli* and *Pasteurella multocida* infections in chickens (in preparation).

[33] PERMIN, A., SCHOU, T.W., SATRIJA, F., LARSEN, M. The effect of parasitism on subsequent vaccination against Newcastle disease (in preparation).

[34] HERD, R.P., MCNAUGHT, D.J., Arrested development and the histotropic phase of *Ascaridia galli* in the chicken, Int. J. Parasitol. **5** (1975) 401-406.

[35] JOHNSON, J.R., HANSEN, M.F., NASSAR, R.F., *Ascaridia galli*: Effects of immunosuppressive drugs or bursectomy in chickens, Exp. Parasitol. **35** (1974) 337-349.