Poultry Science Journal
ISSN: 2345-6604 (Print), 2345-6566 (Online) http://psj.gau.ac.ir
DOI: 10.22069/psj.2018.15213.1340

Follow Up of Maternally Derived Antibodies Titer against Economically Important Viral Diseases of Chicken

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Poultry Science Journal 2018, 6(2): 149-154

Keywords
Virus
ELISA
Broiler chicken
Maternally derived antibody

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Article history
Received: June 9, 2018
Revised: August 18, 2018
Accepted: September 12, 2018

Abstract
The study was conducted to know the rate of maternally derived antibodies (MDAs) transfer from parents to their offspring and declining the MDAs in their chicks at 0, 7, 14, and 21 days of age against four major poultry viruses like Newcastle disease virus (NDV), Infectious bronchitis virus (IBV), Infectious bursal diseases virus (IBDV), and Avian Reo virus (ARV). The MDAs was studied on Grandparent (GP) to Parent stock (PS), and Parent stock (PS) to broiler at 30 weeks and 50 weeks of age in Cobb-500 broiler strain chicken. The MDAs was measured from serum antibody titer by indirect ELISA test. The MDAs transfer rate against NDV from GP to PS at 50 weeks of age was higher (68.82%) than at 30 weeks of age but in case of PS to broiler it was higher (66.01%) at 30 weeks of age and its persistent rate also higher (7.96%) up to 21th days of age. Against IBV, MDAs transfer rates were higher in PS to broiler than GP to PS of both ages and highest rates were revealed in PS to broiler at 30 weeks of age as 70.72%. On the other hand, among all lines MDAs transfer rates against IBDV was higher (86.94%) in GP to PS at 30 weeks of age. For ARV, the MDAs transfer rates were highest in GP to PS in both ages than PS to broiler and within GP to PS at 50 weeks of age, it was highest (94.87%) than 30 weeks of age. Accordingly, the poultry producer may help to develop an effective vaccination schedule by considering the MDAs from above experiment.

Introduction

Maternally derived antibodies (MDAs) are the antibodies that are transferred from mother to her offspring through the egg, placenta, and colostrum or milk (Grindstaff *et al.*, 2003; West *et al.*, 2004; Muniz *et al.*, 2018). The secretions from yolk and oviduct plays major role in immunoglobulin transfer from parents to their hatched chicks (Kimijima *et al.*, 1990; West *et al.*, 2004). As an example, chicken transfer IgG antibodies to their offspring via yolk (Mockett *et al.*, 1987). The MDAs plays a significant role in the protection of chicks from diseases during their young age when they are lack of fully develop immune system (Ahmed and Akhter, 2003; JM, 2008). The MDAs production against most of the viruses are clogged at the age between 15 to 20 days in chicken (Gharaibeh & Mahmoud, 2013). During embryogenesis MDAs provide protection to the chicken embryo and young chicks immediately after hatching (Bencina *et al.*, 2005). Due to the short lifespan of broiler chicken, the presence of high MDAs is very important and economically important in the modern broiler chicken industry (Gharaibeh *et al.*, 2008).

Please cite this article as: Ali MZ & Hasan B. 2018. Follow Up of Maternally Derived Antibodies Titer against Economically Important Viral Diseases of Chicken. Poult. Sci. J. 6(2): 149-154.

The rate of MDAs transfer depends on the level of antibodies titer in blood and age of the hen. The booster revaccination with inactivated vaccine during production period of grandparent stock (GP) resulting higher antibodies in itself as well as transfer higher MDAs into next generation-parent stock (PS). Then MDAs become transfer from PS to its nextgeneration commercial stock (broiler) in the same way (Gharib *et al.*, 2006; Kundu *et al.*, 2018). Vaccination of chicks with live vaccine during the presence of high MDAs can causes the vaccination failour because neutralisation of the live vaccine (Al-Natour *et al.*, 2004; Chhabra *et al.*, 2015). MDAs in young chicks strat declining with age, ultimately diminished after certain period of time if revaccination is not provided on time. Thus, it is important to understand the dyanmics and biology of MDAs in order to prepare proper and effective vaccination schedule in broiler chicken industry. The aim of this study is to estimate the rate and dynamics of MDAs transfer from GP to PS, and PS to broiler chicken at 30 and 50 weeks of age as wel as decay of the MDAs in time in their offsprings at 0, 7, 14, and 21 days of age.

Materials and Methods

The study was conducted on GP, PS, and broiler of cobb-500 broiler strain chicken line. Total 500 1-day old chicks of cobb-500 GP broiler strain were collected from a commercial source. The GP hens were reared for up to 50 weeks of age in the environmental control shed with same temperature, humidity, ventilation and nutrition. All chicks from GP and their next two generation (PS and broiler) also managed in same environmentally control shed with same management practices. The chickens were vaccinated against Newcastle disease virus (NDV), Infectious bronchitis virus (IBV), Infectious bursal diseases virus (IBDV), and Avian Reo virus (ARV). The routes, age, type, and doses of vaccination described in Table 1.

Table 1. The vaccination program of NDV, IBV, IBDV, and ARV diseases on GP, PS, and Broiler from day-old to culling age

Vaccine					Age of administration (Week + Day)		
Name	Strain	Type	Method	Company	GP	PS	Broiler
IBV	H120	Live	Spray	Intervet, Egypt	0+1	0+1	-
IBDV+NDV	D78, Clone 30	Inactivated	SC*	Intervet, Egypt	1+0	1+0	-
IBV+NDV	Ma5, Clone 30	Live	ED*	Intervet, Egypt	1+0	1+0	1
NDV	Clone 30	Live	ED	Intervet, UK	-	-	8
IBDV	D78	Live	ED	Intervet, Egypt	1+4	1+5	1+4
IBDV	D78	Live	ED	Intervet, Egypt	2+4	2+6	18
NDV	Lasota	Live	ED	Intervet, South Africa	3+1	3+3	-
ARV	S1133	Live	ED	Intervet, South Africa	5+1	5+4	-
IBV	4/91	Live	ED	Intervet, UK	8+6	9+3	-
IBV+NDV	Massachusetts, La Sota	Inactivated	SC	Ceva, US	9+5	10+0	-
IBV+NDV	Ma5, Clone 30	Live	ED	Intervet, Egypt	17+3	18+2	-
NDV+IBV+IBDV+ ARV	Clone 30, M41, D78, S1733 and S2408	Inactivated	IM*	Intervet, Egypt	20+2	21+0	-
IBV	Ma5	Live	DW*	Intervet, UK	22+1	23+2	-
NDV	Clone 30	Live	DW	Intervet, UK	23+0	23+6	-
NDV	Clone 30	Live	DW	Intervet, UK	30+5	31+3	-
IBV+NDV	Massachusetts, La Sota	Inactivated	SC	Ceva, US	35+4	36+0	-
ARV	S1733 and S2408	Inactivated	SC	Intervet, UK	36+6	37+4	-
NDV	Clone 30	Live		Intervet, UK	47+0	47+6	-
IBV+NDV	Massachusetts, La Sota	Inactivated	SC	Ceva, US	52+4	53+3	-
IBV+NDV	Ma5, Clone 30	Live	DW	Intervet, UK	59+3	-	-

*SC-Subcutaneous, *ED-Eye drop, *IM-Intramuscular, *DW-Drinking water

Twenty five blood samples were collected from each line of GP and PS at the age of 30 and 50 weeks in order to detect parenteral antibody titer level by indirect ELISA against NDV, IBV, IBDV, and ARV. Again 25 blood samples were collected from the chickens from both GP and PS lines at day 1 in order to detect their maternally derived antibodies (MDAs) titer level against those diseases. Following that we collected 25 blood samples from these chickens at different time point (7, 14, and 21 days) of ages in order to detect the trend of MDAs in blood.

A 3 mL sterilized disposable plastic syringe without anticoagulant was used to collect blood sample. Wing vein of the individual chicken was used to collect blood sample aseptically. Following the collection of blood sample it was left to clot for 1 hour in the syringe (Hamal e*t al,* 2006). Later all the blood samples were kept in the refrigerator at 4°C for 4-5 hours in order to avoiding possible hemolysis. Each serum sample was decanted in 1.5 mL Eppendorf tube and centrifuge at 2,000 × g for 5 min to found clear serum (OIE, 2012). The serum was then transferred to a sterile Eppendorf tube and then stored at -20° C for further use (Ali *et al.,* 2015).

All the serum samples (n=500) were tested for the detection of specific antibody titer against NDV, IBV, IBDV, and ARV by commercial indirect ELISA test kit (BioChek, Holland). The indirect ELISA test protocol was followed according to manufacturer recommendation. To calculate the antibody titer of each individual samples done by BioChek ELISA software.

Results

The mean antibody titer of GP at 30 weeks of age against NDV, IBV, IBDV, and ARV was 17953, 7060, 15699, and 11083 respectively, whereas the same birds shows antibody mean titer at 50 weeks of age as 19181, 11732, 9187, and 14434, respectively. On the other hand, the mean serum antibody titers of PS against NDV, IBV, IBDV, and ARV at 30 weeks of age was 14338, 8176, 12191, and 4277, respectively, while it was respectively 18737, 11222, 18152, and 6742 at 50 weeks of age in same PS. The MDAs transfer from GP at 30 weeks to PS at 0 days chicks was 11835, 3167, 10454, and 7928 against NDV, IBV, IBDV, and ARV respectively, but titer declines at 21 days of age in same chicks as 568, 52, 78, and 86, respectively. At 50 weeks of age the same GP hens transfer MDAs to PS chicks at 0 day of age as 13201, 4765, 7987, and 13693 and this titer declined at 21 day of age as 589, 128, 89, and 181, respectively (Table 2). In NDV, the transfer of MDAs from GP to PS at 50 weeks of age was higher (68.82%) but in case of PS to broiler it was higher (66.01%) at 30 weeks of age (Table 3). It was observed the difference of MDAs transfer to chicks from PS to broiler at day 1 of age and this antibody titer declined up to 21 days. In IBV, transfer of MDAs was higher in both lines (GP to PS and PS to broiler) at 30 weeks of age, but titer declined at 7th days of age of PS to broiler at 30 weeks of age. The MDAs transfer rates in both IBDV and ARV were higher at 50 weeks of age in both lines (Table 4).

Table 2. The Geometric Mean Titer (GMT) of MDAs against NDV, IBV, IBDV, and ARV of GP and PS at 30 and 50 weeks of age and their corresponding offspring at 0-21 days

MDAs[1] titer transfer from GP to PS										
Pathogen	GP at 30wks[1]	GP (30wks) to PS[2] (day)				GP at 50wks[1]	GP (50wks) to PS[2] (day)			
		0	7	14	21		0	7	14	21
NDV	17953	11835	3891	1081	568	19181	13201	4187	1115	589
IBV	7060	3167	1204	325	52	11732	4765	1347	625	128
IBDV	15699	10454	3478	897	78	9187	7987	2054	586	89
ARV	11083	7928	583	154	86	14434	13693	953	427	181
MDAs transfer from PS to Broiler										
Pathogen	PS[2] at 30wks1	PS[2] (30wks) to Broiler(day)				PS[2] at 50wks[1]	PS[2] (50wks) to Broiler (day)			
		0	7	14	21		0	7	14	21
NDV	14338	9464	3532	1130	753	18737	11820	4251	1018	689
IBV	8176	5782	1386	237	83	11222	6405	1631	615	119
IBDV	12191	6074	2968	611	43	18152	10454	4152	1182	365
ARV	4277	1486	210	95	30	6742	2355	325	55	18

1= Antibody level calculated as GMT by BioChek ELISA software, 2=PS (Parent stock)

Table 3. MDAs transfer rate and decay this anybody titer up to 21 days as percentage

MDAs[1] transfer from GP to PS								
Pathogen	GP (30wks) to PS[2] (day)				GP (50wks) to PS[2] (day)			
	0	7	14	21	0	7	14	21
NDV	65.92	32.87	9.13	4.79	68.82	31.72	8.45	4.46
IBV	44.86	38.02	10.26	1.64	40.62	28.27	13.12	2.69
IBDV	66.59	33.26	8.58	0.75	86.94	25.72	7.34	1.11
ARV	71.53	7.35	1.94	1.08	94.87	6.96	3.12	1.32
MDAs transfer from PS to Broiler								
Pathogen	PS[2] (30wks) to Broiler(day)				PS[2] (50wks) to Broiler (day)			
	0	7	14	21	0	7	14	21
NDV	66.01	37.32	11.94	7.96	63.08	35.96	8.61	5.83
IBV	70.72	23.97	4.09	1.43	57.07	25.46	9.60	1.86
IBDV	49.82	48.86	10.05	0.70	57.59	39.72	11.31	3.49
ARV	34.74	14.13	6.39	2.01	34.93	13.80	2.34	0.76

1= Antibody level calculated as GMT by BioChek ELISA software, 2=PS (Parent stock)

Table 4. MDAs transfer rate from GP to PS and PS to broiler at 30 and 50 weeks of age as percentage

Type	NDV	IBV	IBDV	ARV
GP (30wks) to PS DOC	65.92	44.86	66.59	71.53
GP (50wks) to PS DOC	68.82	40.62	86.94	94.87
PS (30wks) to Broiler DOC	66.01	70.72	49.82	34.74
PS (50wks) to Broiler DOC	63.08	57.07	57.59	34.93

Discussion

Since 1926, the NDV virus is curing high mortality and significant losses in poultry production worldwide (Kapczynski *et al*., 2013). In this study, Tthe transfer rate of MDAs from GP to PS against NDV was the highest as 68.82% (GMT 13201) at the age of 50 weeks than 30 weeks, whereas in previous study it was 29.2% on commercial broiler (Gharaibeh *et al*., 2008; Baron *et al*., 2018) and 35.5 to 40.7% in broiler breeder to commercial broiler stock at 39 weeks of age (Hamal *et al*., 2006). On the other hand transfer of MDAs from PS to broiler was higher at 30 weeks of age as of 66.01% (GMT 9464) and decline to 37.32% (GMT 3532) at the age of day 7th that is important to develop protective immunity in commercial stock to combat field NDV (Kapczynski *et al*., 2013).

The transfer rate of MDAs against IBV was highest at 30 weeks of age in both lines (GP to PS and PS to broiler) and higest MDAs transfer in PS to broiler as 70.72% (GMT 5782) at 30 weeks of age. The similar finding was also reported by Gharaibeh *et al*. (2008) and Elhady *et al*. (2018) that IBV had the second highest MDAs transfer rate (38.6%) after IBDV. The MDAs decline rate of IBV from PS to broiler at 30 weeks of age was higher as 70.72% (GMT 5782) to 23.97% (GMT 1386) from day-old to 7th day of age. Similar results of decline rates of IBV antibodies from parents to offsprings were found in (Gharaibeh & Mahmoud, 2013) as GMT 6706 to GMT 860 at 5th day and GMT 15 at 10th day age of chicken. There are six different serotypes of IBV that infect the reproductive systems of chicken (Gelb *et al*., 1991). It helps to develop MDAs by activation of mucosal immunity in the reproductive tract (Cavanagh, 2008).

In this study the transfer rate of MDAs against IBDV found highest in 50 weeks of age in both lines. The highest IBDV antibodies transfer occur from GP to PS at 50 weeks of age as 86.94% (GMT 7987). Similarly Gharaibeh *et al*. (2008) found highest percentage of MDAs transfer as 73.6% among the all pathogen tested. The highest and lowest decay of MDAs at 21th day old chicks of IBDV was found in PS to broiler at 50 weeks and 30 weeks of age as GMT 43 and GMT 365, respectively. The finding is in line with the results of Gharaibeh *et al*. (2008) and Sze *et al*. (2016), where they show decay of maternal antibodies against IBDV at 20th day of age was GMT 546. Another findind was described by a study (Ahmed & Akhter, 2003) stongly agreed with the reults, they observed MDAs of IBDV persistted in chicken up to 21th days were determined by ELISA.

Chicken are high susceptable to ARV in the post hatching period (van Loon *et al*., 2003; van Loon *et al*., 2004). The MDAs transfer rate against ARV was highest at 50 weeks of age from GP to PS as 94.87% (GMT 2355) but it

declines as 1.32% (GMT 181) at 21th day of age. However, the finding differ with the results of previous study (Gharaibeh *et al*., 2008; Ren *et al*., 2018) where they showed the transfer of MDAs against ARV to offsprings at 20th day of age as GMT 0. This disagreement might be differentiation on vaccination schedule.

Conclusion

The study reveled that MDAs transfer rate is higher in 50 weeks than 30 weeks of the parenteral age except IBV and decline this antibody titer up to half within first weeks of age. NDV, IBV, IBDV, and ARV are economically important to poultry producers. Proper vaccination schedule is very important to prevent these viral diseases in the farms. The findings of this study will be useful to both poultry farmers and veterinarians to help them to prepare an effective vaccine schedule.

Conflict of interest

The authors declare that there is no conflict of interests.

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