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A Review: The Use of In Ovo Feeding in Various Types of Poultry

Review: Penggunaan in Ovo Feeding Pada Berbagai Jenis Unggas

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ABSTRACT

In ovo feeding is one way to increase poultry productivity by providing additional nutrition during the incubation period and can increase embryo growth. Many implementations of in-ovo feeding techniques have been carried out on various types of poultry, but a summary of the use of in-ovo feeding on various types of poultry has never been reported, therefore this study was conducted. This review article aims to determine the use of in-ovo feeding in various types of poultry. This study was conducted based on literature studies by analyzing secondary data and synthesizing research from various data sources originating from nationally accredited journals and reputable international journals that discuss the use of in-ovo feeding in various types of poultry. The study shows that the implementations of in-ovo feeding for various types of poultry have been mostly applied to broiler chickens and native chickens, but only a few in geese, ducks, and quails. In-ovo feeding has several advantages for enhancing nutrition and health, including preserving normal physiological status and preventing disease, so that poultry productivity can be increased.

Keywords: growth, In Ovo Feeding, poultry, productivity

ABSTRAK

In ovo feeding adalah salah satu upaya untuk meningkatkan produktivitas unggas dengan pemberian nutrisi tambahan pada periode inkubasi dan dapat meningkatkan pertumbuhan embrio. Telah banyak dilakukan implementasi teknik in ovo feeding pada berbagai jenis unggas, namun rangkuman dari penggunaan in ovo feeding pada berbagai jenis unggas belum pernah dilaporkan, oleh karenanya, studi ini dilakukan. Artikel review ini bertujuan untuk mengetahui penggunaan in ovo feeding pada berbagai jenis unggas. Studi ini dilakukan berdasarkan studi literatur dengan menganalisis data sekunder dan mensintesis penelitian dari berbagai sumber data yang berasal dari jurnal terakreditasi nasional dan jurnal internasional bereputasi yang membahas mengenai penggunaan in ovo feeding pada berbagai jenis unggas. Hasil studi menunjukkan bahwa penggunaan in ovo feeding pada berbagai jenis unggas telah banyak dilakukan pada ayam broiler dan ayam kampung, namun masih sedikit pada angsa, bebek dan puyuh. Penggunaan in ovo feeding pada berbagai jenis unggas memberikan banyak manfaat terhadap perbaikan nutrisi dan kesehatan, termasuk mempertahankan status fisiologis normal dan pencegahan penyakit, sehingga meningkatkan kinerja produksi unggas.

Kata kunci: In Ovo Feeding, pertumbuhan, produktivitas, unggas

INTRODUCTION

The poultry industry has a very important role in the economy because the poultry industry is able to produce self-sufficient poultry meat nor eggs. Poultry eggs and meat are sources of animal protein that are rich in vital amino acids that are beneficial to people's health. Slowing obstacle the poultry farming business is the level of growth and productivity of poultry. Feed technology for chickens has also continued to develop until now in order to obtain better livestock productivity (Krisnan 2019). One way to increase poultry productivity is by providing additional nutrition during the incubation period through the in-ovo technique, which can increase embryo growth. In ovo feeding technology serves to overcome constraints on early growth during the embryonic phase and growth after hatching in poultry (Uni and Ferket 2003).

At present, the growth of chickens throughout their embryonic and neonatal development (growth at the time of hatching) accounts for close to 50% of their productive age, according to the current livestock industry. Therefore, the embryonic period and the development of the neonatal phase is an important phases in achieving quality poultry growth performance. In principle, Before and after hatching is a crucial times for a chick's growth and development. During this time, the digestive system rapidly matures, adapts to an environment for external feeding, and makes use of the nutrients found in egg yolks (Ferket 2012).

Early access to food is necessary for the development of the digestive tract, but a number of practical issues slow down or limit the growth of chicks after hatching. Incubation of the eggs results in hatching in around 21 days. Early and late-hatched chicks are both shed at the same time, even though approximately 95% of them are between 36 and 48-hour intervals and are then denied food for 48 to 72 hours until they reach commercial chicken farms. Minerals, protein, fat, and fat-soluble vitamins included in egg yolks are vital for the survival of chicks until they have access to nutritious food and clean water. Long-term famine has a number of negative effects, such as poor growth rates and decreased feed conversion efficiency.

Early exogenous feed consumption after hatching is linked to the quick development of the digestive system and organs (Roto *et al.* 2016). The yolk, which is rich in lipids but contains relatively modest quantities of carbs and protein, provides sustenance and energy throughout incubation. Through the endocytosis pathway, yolk lipids are directly delivered to the circulation in poultry embryos (Noy and Sklan 2001), but after hatching, the digestive tract digests and absorbs the yolk's contents. Alternative methods, such feeding right away after hatching in the hatchery, have been demonstrated to enhance performance during this early stage (Krisnan 2019) and in ovo feeding (Lokesha *et al*. 2017; Saeed *et al*. 2019; Arain *et al.* 2022).

The in-ovo feeding (IOF) technique with various ingredients in an effort to suppress the immune response, both humoral and cellular, open opportunities for the commercial use of this technology for poultry. Therefore, IOF technology can be the right choice to ensure that livestock from the embryonic phase are getting or consuming nutrients properly before hatching. The successful control of Marek's disease using the ovo vaccine technique in the early 1980s inspired the development of this IOF technology in chicken research (Sharma and Burmester 1982). Then, in order to ensure that the embryos ingest the amniotic fluid prior to hatching, the vaccine material is replaced with a high-volume 18-nutrient substance that is injected into the amniotic fluid of chicken and turkey eggs (Uni and Ferket 2003).

The study proved to provide a better response to chickens in the early phase of life or the neonatal phase. Therefore, IOF is considered very possible in providing nutrients as early as possible for the proper development of embryos and neonatal chicks. IOF is referred to as one of the six key topics of the poultry business moving forward since it is regarded as an innovative technology that has significantly impacted the broiler sector over the past 20 years (Mavromichalis 2017). Currently, the IOF technique continues to develop and many studies reports whether it is done manually or automatically. IOF's research object also penetrated into various types of poultry. In Indonesia, this IOF technique has also been developed for local chickens, namely KUB chickens (Krisnan 2019).

IOF has been shown to reduce mortality and morbidity after hatching, improve the efficiency of utilization of feed nutrients in the neonatal phase, increase the immune response, reduce the incidence of disorders of skeletal development, and increase the development of muscle and meat (Uni and Ferket 2003). Materials that can be converted into IOF nutrients include a wide range of substances, including amino acids (Ohta *et al.* 2001; Yu *et al.* 2018; Krisnan 2019; Ajayi *et al.* 2022), carbohydrates (Tako *et al.* 2004; Uni *et al*. 2005; Smirnov *et al*. 2006; Tenggara *et al*. 2010; Baykalir, Mutlu and Erisir 2021), vitamins (Nowaczewski *et al*. 2012; Araujo *et al*. 2019; Zhu *et al*. 2020), minerals (Tako *et al.* 2004; Sun *et al.* 2018), fatty acids and other nutritional substances.

The placement of the injection of nutrients also varies depending on the nutrients injected. The use of IOF materials, dosages, and methods of injection for each type of poultry is interesting for more in-depth study in order to obtain the right and better IOF technology. Many in-ovo feeding techniques have been carried out on various types of poultry, but the summary of the use of IOF in various types of poultry has never been reported, therefore, this study was conducted. This review article aims to determine the use of in-ovo feeding in various types of poultry.

MATERIALS AND METHODS

This study was conducted based on literature studies by analyzing secondary data and synthesizing research from various data sources originating from nationally accredited journals and reputable international journals which discuss the application of IOF to diverse poultry species. The data sources used came from journals published in the last 10 years, namely from 2012 to 2022. Journals were searched through the websites Google Scholar, Scopus, PubMed, Science Direct, Elsevier, and Researchgate using the help of the Publish or Perish application.

RESULTS AND DISCUSSION

Overview of In Ovo Feeding and Its Application to Various Poultry Types

The in-ovo approach involves injecting a separate chemical either directly into the growing embryo or into the hatching egg. In a laboratory experiment, Sharma and Burmester (1984) proposed the concept of in-ovo technology and claimed that in-ovo vaccination may successfully shield birds from Marek's disease (MD). In the past, MD vaccinations were typically administered manually. Broiler hens were first given vaccinations against Marek's illness and Gumboro's disease using in-ovo technology about 29 years ago (Ricks *et al.* 1999).

Since then, it has been used in a much larger range of commercial settings to achieve immunization against several infections, as well as to promote embryonic development, an immune response, and the growth of helpful bacteria (Madej and Bednarczyk 2016). The first automated method for in-ovo immunization created by Embrex, Inc. and released in the United States is called Inovoject (Ricks *et al.* 1999). Now, there have been many researches and applications in-ovo the feeding of certain nutritious materials. The main advantages of IOF injection are reducing the chance of human error, quickly immunizing huge numbers of eggs, minimizing labor costs and earlier developing avian immunity (Uni and Smith, 2017). Usually, when eggs are sent from the setter to the hatcher, the IOF injection procedure is finished in a short amount of time, so the IOF makes a significant contribution to increasing commercial-scale poultry production (Arain *et al.* 2022).

In modern hatchery practices, when 95% of the eggs have hatched, chicks start to emerge from the eggs at variable intervals, usually after 36 to 48 hours. After hatching, the young chicks are retained for various hatchery procedures before being delivered to the production farm, where they must remain for an additional period of up to 72 hours. The remaining yolk helps to provide energy for growth and maintenance during this time, when chicks typically starve after hatching due to a lack of food and water until they reach the production farm (Sklan and Noy 2000).

The amniotic route is the most popular in-ovo injection location because the embryo ingests the amniotic fluid and its contents to the intestine and enteric cells. As a result, the medication injected here directly will be ingested along with the amniotic fluid and transported to the intestinal tissue. The IOF injection site can be illustrated in Figure 1.

Use of In Ovo Feeding on the Performance of Various Poultry Species

Uni and Ferket (2004) suggested that chickens will naturally consume amniotic fluid just before hatching. Therefore, In the days before hatching, nutritional solutions added to the embryo's amniotic fluid will provide vital nutrients to the embryo's intestines. The best in ovo injection timing, according to Salahi *et al*. (2011), was 18 days of incubation. Another important factor in IOF applications is the type of material to be used. This material will determine the technical formulation and the expected goals of supplementation carried out through IOF (Krisnan *et al*. 2019). Materials that can become IOF nutrition are quite diverse and provide different benefits to various types of poultry as presented in Table 1.

The results of research from various sources presented in Table 1 illustrate that the supplementation of several nutrients through the IOF technique in poultry generally shows a positive effect on the development or growth and productivity of livestock. This effect is related to many benefits, which include improving hatching parameters such as hatchability and hatching weight, improving livestock appearance or performance, improving digestive organs (intestinal villi size and function), improving bones and meat, and increasing immunity.

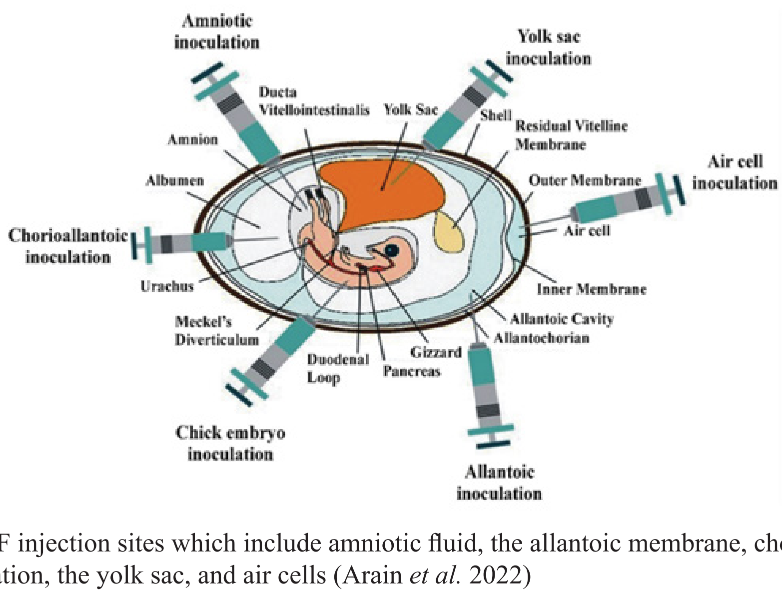

Figure 1. The IOF injection sites which include amniotic fluid, the allantoic membrane, chorioallantoic inoculation, the yolk sac, and air cells (Arain *et al.* 2022)

Table 1. Effect of the use of In Ovo Feeding technology in various materials and different types of poultry

Poultry type	Nutrition Group	Type of Nutrition	Delivery Time (Incubation Period days to-)	Place of Injection	Effect on poultry	Reference
Broiler Chicken	Amino acid	cysteine and lysine	17.5	Amnion	Improve antioxidant status, improve intestinal morphology	Ajayi *et al.* 2022
		L-Arginine	17.5	Amnion	Increase body weight	Yu *et al*. 2018
	Vitamin	Vitamin C	11	Yolk Sac	Increase hatchability, increase the content of vitamin C in blood plasma, increase the level of mRNA expression	Zhu *et al*. 2020
		Vitamin E	17.5	Amniotic Cavity	Increase hatchability, increase hatching weight, increase small intestine weight	Araujo *et al.* 2019
	Mineral	Zinc	9	Yolk Sac	Increases embryo mortality, reduces hatchability, Increases Chick hatch weight	Sun *et al*. 2018
		Zinc	9	Yolk sac	Increases Zn content in embryonic tibia and MT mRNA expression level in embryonic liver	Xiao-ming *et al.* 2017
Native chicken	Amino acid	L-Arginine	10	Albumin	Increases the weight of the ilium, increases the height of the duodenal and ileal villi	Azhar *et al.* 2022
		L-Lysine	14	Albumin	Increase immunity	Taha-Abdelaziz *et al.* 2018
	Mineral	Selenium	18	Amnion	Building immunity and producing good growth performance in chickens.	Krisnan et al. 2019
Swan	Carbohydrate	D-Glucose monohydrate and ascorbic acid	25	Albumin	Reducing hatchability, increasing embryo mortality	Baykalir, Mutlu and Erisir 2021
Duck	Carbohydrates and Amino Acids	Carbohydrates and arginine	23	Amniotic Cavity	Increase hatchability, increase liver glycogen	Tangara *et al.* 2010
Quail	Amino acid	L-Histidine, L-Lysine and L-Arginine	13	Amniotic fluid	Increase hatching weight, increase organ weight	Zhang *et al*. 2018

Based on Table 1 it can also be seen that the use of in ovo feeding on various types of poultry has been mostly done on broiler chickens and native chickens, but only a few on geese, ducks and quail. The use of IOF in various types of poultry provides many benefits for improving nutrition and health, including maintaining normal physiological status and preventing disease, thereby increasing poultry production performance.

The main goals of in ovo administration are to expose the developing embryo to the various nutrients needed to stimulate development of the gastrointestinal tract (GIT), enhance immunity, antioxidant defenses, increase the beneficial microbial population, improve digestion and absorption and reduce the deleterious effects of starvation (Krisnan *et al*. 2019). The results showed that early feeding significantly improved chick quality and post-hatch performance of broilers and also reduced the adverse effects of delayed hatching windows (Abousaad *et al*. 2017).

The choice of location in the amnion for injection of IOF nutrition is a location that is widely used in various types of poultry. Kadam *et al*. (2013), stated that yolk fat is directly transported into the blood circulation by endocytosis during embryonic development (hatching period) and the contents of the yolk are also transported through the yolk stalk to the small intestine after approaching the time of hatching, namely when the condition of the yolk begins to enter the embryo (internalization of egg yolk). Another opinion states that chicken embryos will naturally consume amniotic fluid before hatching (Uni and Ferket 2004) so that the addition of a nutrient solution to the amniotic fluid of the embryo will provide essential nutrients to the embryo's gut.

Regarding the effective time for IOF injection, it depends on each type of bird. In broiler chickens, ages 11-18 show good effect. Salahi *et al.* (2011) provided evidence that the best ovo injection time was 453 hours of incubation period. The results of the research by Krisnan *et al.* (2019), explained that the method for developing manual in ovo feeding (IOF) injection techniques is recommended to use a needle with a length of 0.8–0.9 cm in the amnion when the egg is 18 days of incubation. It was further explained that the treatment of shell closure after IOF injection was not significantly different from the percentage of hatchability so that the treatment without cover was considered more efficient as an option (Krisnan *et al.* 2019).

Future Studies

The IOF technique holds promise for many benefits, including reduced post-hatch morbidity and mortality, greater efficient utilization of nutrients at an early age, enhanced immune response to enteric antigens, reduced occurrence of developmental skeletal disorders, increased muscle enlargement and breast meat production. This has opened up new opportunities for initial nutrition providing prospects for nutritionists to increase poultry production to optimal levels. Although the IOF administration method has yielded many positive responses in the perinatal stage of poultry, how sustainable this method is for poultry growth and production is still not well understood. There is still much debate among scientists about the long-term benefits of giving IOF which really needs to be studied further. It is necessary to develop a standard way or method of administering IOF. When the standard exists, its large-scale implementation and acceptance as a standard poultry feeding system would be highly prospective.

CONCLUSION

The study results show that the use of in-ovo feeding on various types of poultry has been mostly done on broiler chickens and native chickens, but only a few on geese, ducks and quail. The choice of location in the amnion for injection of IOF nutrition is a location that is widely used in various types of poultry. The use of in-ovo feeding in various types of poultry provides many benefits for improving nutrition and health, including maintaining normal physiological status and preventing disease, there by increasing poultry production performance.

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