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Feeds and Feeding of Ducks in India-An Overview

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ABSTRACT

The role of livestock and poultry in nutritional and livelihood security and doubling farmers' income is highly important. In India, among alternate poultry species, the contributions of ducks for egg and meat production are next to chicken. The important available ducks are few exotic breeds and locally available indigenous breeds. Generally, ducks are reared under extensive or semi-intensive or intensive rearing systems. Based on different rearing systems, the feeds of ducks are more diversified. The literature available on nutrient requirements for different types of ducks and nutrient contents of different feeds in different rearing systems is very meagre. To minimize the cost of production, many locally available low cost feed ingredients or alternate or unconventional feed ingredients like broken rice, azolla, tuber crops (cassava), different insects, earthworm, etc are used for feeding of ducks. Feed additives like ginger and vitamin (Vitamin-C and E) and mineral (Zn and Se) are highly beneficial, when supplemented in duck diets. The feed intake and nutrients metabolisability varies according to the types of ducks, physiological conditions and rearing systems. The important issues with duck feeding are monitoring of feeding, wastage of feed, wetter faeces, Aflatoxins, energy density of the diet, use of fishmeal, fishy flavour of egg, etc. There are many challenges with respect to feeds and feeding of ducks in India. The research carried out on ducks is very limited and more attention should be given on various aspects of duck research. In the scenario of climate change, various nutritional interventions have important role for sustainable duck production by which employment generation and in turn improving its contribution towards nutritional and livelihood security of the farmers of the country.

KEY WORDS: Duck, Feeds, Feeding, India, Overview

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INTRODUCTION

The nutritional and livelihood security and economy of the country is mainly dependent upon the status of the rural famers, who are landless, small or marginal. The role of livestock and poultry in nutritional and livelihood security and doubling farmers' income is highly important. However, the production and productivity of livestock and poultry is affected largely by the climate change. Under these situations, feeding with integration approach is highly desirable in small scale livestock and poultry production with locally available breeds which are climate resilient genetic stocks. India has human population of approximately 1.41 billion (stands 2nd in the global rank); and the requirement for egg and poultry meat is 180 and 10.8 kg per person per annum, respectively; however, the per capita availability of egg and poultry meat is only 86 and 2.2 kg, respectively. In India, among alternate poultry species, the contributions of ducks for egg and meat production are next to chicken. The common domesticated ducks are *Anas platyrhynchos domesticus* or Muscovy ducks (*Cairina moschata*). The important ducks available in the country are few exotic breeds (Khaki Campbell, White Pekin, etc.) and locally available indigenous breeds (Pati, Maithili, Nageswari, Kuttanad (Chara, Chemballi), indigenous ducks of Tamilnadu (Kollam, Arni, Sanyasi, Keeri), indigenous ducks (Desi or Kuzi) of Odisha, local ducks of Andaman, different crossbred, Muscovy (Moti) ducks, etc. (Naik et al., 2022a, 2022b).

In India, ducks are generally reared under

extensive or semi-intensive or intensive rearing systems and the nutrient requirements, availability of feeds and the performance of the ducks are highly influenced by the type of rearing systems (Naik et al., 2022f). It may be backyard scavenging system or nomadic system. In scavenging system, ducks are completely allowed to scavenge outside (within or beyond the farm) and only provided with night shelter. In nomadic (transhumant) system, ducks are allowed to scavenge beyond the locality. The duck farmers mostly belong to poor, small or marginal income group and the ducks are reared as subsidiary source of income. Under semi-intensive rearing system, the ducks are kept in the house and are provided with supplementary feed (commercial or locally available homemade) after allowing them to scavenge outside during day time. This semi-intensive rearing system is mostly practiced by the farmers in an integrated farming system (IFS) approach. In the IFS, the different individual farming system complements each other for better production and more profit. The different duck based IFS are duck-fish, duck-rice, duck-rice-fish, etc. Under intensive rearing or confined system, ducks are exclusively kept in closed house with or without provision of water channels. They are not allowed to scavenge outside. Provision for feed and water are made inside the closed house. They are mostly kept in deep litter system, in which paddy husk or chapped straw are used as bedding material. This system is practiced in commercial farms for meat and egg production. In this system, the monitoring of the ducks for various feeding and health management can be made very closely. Various aspects like nutrient requirements, different feeds, feed additives and supplements, important issues with duck feeding, challenges and future research have been discussed in this review article that will benefit all types of duck farmers, academicians and researchers.

NUTRIENT REQUIREMENTS

The nutrient requirements of White Pekin ducks have been provided by NRC (1994), in which three types of diets has been suggested *i.e.* from 0-2 weeks (22% CP, 2900 kcal MEn/ kg), 2-7 weeks (16% CP, 3000 kcal MEn/ kg) and breeding (15% CP, 2900 kcal MEn/ kg). Besides, the requirements for amino acids (arginine, isoleucine, leucine, lysine, methionine, methionine+cystine, tryptophan, and valine); macro minerals (calcium, chloride, magnesium, nonphytate phosphorous and sodium); trace minerals (manganese, selenium and zinc); fat soluble vitamins (A, D_3, E and K) and water soluble vitamins (niacin, pantothenic acid, pyridoxine and riboflavin) have been provided. The nutritional requirements of meat type (White Pekin) and egg type (Longyan) ducks have been reviewed by Fouad et al. (2018). The recommendations on different nutrient requirements for Pekin ducks has been reviewed by Adeola and Chen (2022).

In India, the research on ducks is still in very primitive stage and only few literatures are available on nutrient requirements, feeds and feeding. Five types of practical levels of nutrients and diets have been suggested by Singh and Panda (1996) for ducks *i.e.* starter (0-2 weeks), grower (3-8 weeks), grower (9-20 weeks), layer and breeder, separately. The suggested practical levels of different nutrients in feed for ducks are energy, protein; amino acids (arginine, glycine and/ or serine, histidine, isoleucine, leucine, lysine, Methionine, Methionine+cystine, phenyl alanine, phenyl alanine + tyrosine, threonine, tryptophan and valine); minerals (calcium, phosphrous, sodium, copper, iodine, iron, manganese and zinc); vitamins (biotin, choline, folic acid, niacin, pantothenic acid, pyridoxine, riboflavin, thiamine, vitamin A, vitamin B_{12}, vitamin D, Vitamin E and vitamin K). The suggested practical level of amino acids in feed for duck has been provided as percentage protein and percentage diet. Nutrient requirements for Khaki Campbell and other breeds of Indian ducks have been suggested by Mandal et al. (2004) and ICAR (2013). The protein level in the diet of Khaki Campbell ducks should be maintained at 22% during starter (0-8 weeks) period (Joshi et al., 2014). During growing stage of Khaki Campbell ducks, 16% CP was beneficial for better reproductive organ growth and early sexual maturity (Giri et al., 2015). Mohanty et al. (2016) suggested 18% crude protein in the ration of Khaki Campbell layer ducks

with respect to egg production, feed consumption and feed conversion ratio. Diet containing 2900 Kcal ME per kg was for optimal growth during starter (0-6 weeks) and 2700 Kcal ME per kg diet during layer (20-40 weeks) stage of white Pekin ducks has been recommended (Sahoo et al., 2022)

DUCK FEED

Based on different rearing systems, ducks feeds are more diversified. There are large variations in the nutrient content the feeds consumed by the ducks under extensive or semi-intensive rearing systems in different areas of the country; and the literature available is very scanty; which leads to very difficult in feed formulation. Under extensive and semi-intensive rearing systems, ducks mostly scavenge on fallen paddy grains, seedlings, small fishes, frogs, snails, insects, earthworms, green tender leaves, grasses, aquatic weeds, beetles, grasshoppers, snails, slugs, mosquito pupae, larvae, small snakes, other aquatic animals, etc. Generally, during rainy seasons, ducks get more protein but less energy. During winter, ducks get more energy and less protein. On the other hand, during lean period both energy and protein are deficient. Further, under semi-intensive rearing system, the supplementary feeds may be kitchen waste, rice paste or homemade or commercial feed. There were 64.01% paddy grains, 23.15% crab, 4.07% snails, 2.02% worms, and 6.75% weeds in the crop samples of nomadic ducks (Anitha et al., 2009). The crop contents (paddy grains, crabs, snails, worms, and weeds) of ducks contained 41.0-53.0% moisture, 10.2-17.5% CP, 11.3-19.8% CF, 1.8-3.7% EE, and 9.5-17.0% total ash; however, the mean fibre fractions, *viz.*, neutral detergent fibre (NDF) and acid detergent fibre (ADF) ranged between 28.1 to 39.5 and 12.7 to 23.4%, respectively (Anitha et al., 2012). However, the feeds of ducks reared under intensive rearing system are comparatively uniform and balanced and nutrient content of the feed ingredients can be analysed before feed formulation.

Generally, like chicken, commercial duck feed is not available in most parts of the country. However, feeds can be prepared at home for ducks depending upon their physiological stages and level of production. A standard duck feed contain cereal, cereal by-products, vegetable proteins, animal proteins, minerals & vitamins supplements and additives. Toxin binders must be added in duck feeds for binding of harmful substances, mostly mycotoxins or endotoxins, within gastrointestinal tracts of the birds. The feeds of ducks can be of two forms *i.e.* mash or pelleted. The mash feed can be fed either as dry or wet. However, ducks prefer to eat dry mash feed, only if they are fed from the duckling stages. The pellet size of the starter (0 to 2 weeks) and grower (after 2 weeks) diets should be 3.18 mm and 4.76-mm diameter (NRC, 1994).

Important low cost feed ingredients

To minimize the cost of production, many locally available low cost feed ingredients or alternate or unconventional feed ingredients like broken rice, azolla, tuber crops (cassava), different insects, earthworm, etc are used for feeding of ducks.

Broken rice or Rice kani

Broken rice (rice kani) can replace wheat at 50% level in the starter feed, grower feed and layer feed (during 1st year of laying) of White Pekin ducks to minimize the cost of production under intensive rearing system (Naik, 2022a; 2022c, 2022d). However, wheat can be replaced by broken rice completely in the diets of White Pekin ducks during 2nd year of laying under intensive rearing system without affecting blood biochemical profile, egg quality and metabolisability of various nutrients (Naik et al., 2020a, 2020b; Naik et al., 2021; Naik et al., 2022e).

Azolla (*Azolla pinnata*)

Azolla (*Azolla pinnata*) is a promising suitable feed substitute for backyard duck farming (Swain et al., 2022a). Azolla contains 4.70-6.60% DM, 20.45-28.54% CP, 11.20-15.91% CF, 2.37-4.60% EE, 36.50-37.10% ADF, 48.20-54.80% NDF, 0.80-2.22% Ca and 0.35-1.29% total phosphorous (Swain et al., 2022b, 2022c). There was an increase in Roche fan colour score (7.41 vs 6.22), 30% and reduced feed cost, when fresh azolla was

supplemented in the feed of backyard ducks at the rate of 200g per duck per day (Sujatha et al., 2013). Similarly, supplementation of fresh azolla @ 200g/ duck/day by substituting 20% of standard duck layer diet improved the egg production, egg weight, feed conversation ratio, performance efficiency index and shape index with enrichment of yolk colour in White Pekin laying ducks (Swain et al., 2018). Further, feeding of dried azolla at 10% level in the diet of Khaki Campbell laying ducks was also beneficial in terms of improved egg quality and reduction in feed cost with enriched yolk colour without any adverse effect on the production performance (Swain et al., 2020).

Cassava (*Manihot esculenta*)

Cassava (*Manihot esculenta*) tuber meals can replace maize up to 40% without affecting the growth and production potential of White Pekin ducks (Sahoo et al., 2014). Cassava can be included in the starter feed of White Pekin ducks, replacing wheat up to 50% level for meat production (Naik, 2023).

Insects

Several insects are potential substitute for fishmeal (FM) and soybean meal (SBM); and can be produced in large scale for feeding of ducks. The commonly used insects are black soldier fly, housefly, etc (Khan, 2018).

Earthworm (*Eisenia foetida*)

Earthworm meal contained 19.76 % DM, 55.76 % CP, 5.68 % EE, 11.32 % CF, 13.73 % Total ash, 6.19 % Acid insoluble ash and 13.51 % NFE; and can be used as an alternative protein sources in duck feed (Swain, 2023).

FEED ADDITIVES AND FEED SUPPLEMENTS

Herbal feed additives

Supplementation of dried ginger (*Zingiber officinale*) powder @ 1g/ kg feed was effective in enhancing immunity, improvement of reproductive performance and protecting against hepatorenal toxicity in White Pekin ducks by minimizing the oxidative stress induced by arsenic (Panda et al., 2021a, 2021b, 2022). The supplementation of dried garlic (*Allium Sativum*) powder @ 2g per kg feed had protective effect against arsenic induced immunotoxicity, elevated cardiac biomarkers, oxidative stress, gross and histopathological lesions in White Pekin ducks (Das et al., 2021, 2022).

Vitamin and mineral supplements

Supplementation of vitamin C @ 250 mg and vitamin E @ 75 mg per kg feed ameliorated the stressful impacts of high ambient heat and relative humidity in White Pekin ducks across peak summer (Jena et al., 2017). The combined supplementation of Se @ 0.3 mg and Zn @ 40 mg per kg feed alleviated the summer induced heat stress in White Pekin ducks (Kumar et al., 2018). The dietary supplementation of vitamin C @ 500 mg per kg feed ameliorated the summer induced heat stress in White Pekin ducks by improving haemato-biochemical parameters and reducing oxidative stress in White Pekin ducks (Behera et al., 2020).

FEED INTAKE AND NUTRIENT METABOLISABILITY

Daily feed intake of 110 g per bird has been reported in Desi ducks. The cumulative feed intake (g) per duck during 0-4 weeks, 5-8 weeks and 0-8 weeks were 1650.94-1746.59, 2871.68-3096.34 and 4522.82-4792.75, respectively. In KC ducks, the feed intake (g) at 1st week, 4th week and 8th week were 16.13-17.21, 99.93-105.56 and 101.21-114.00, respectively. In WP ducks, the daily feed intake was 117.61-136.38 g, 137.71-162.59 g and 142.97-160.31 g, at 4th week, 6th week and 8th week, respectively (Naik et al., 2022b).

The metabolisability (%) of dry matter, organic matter, crude protein, ether extract, crude fibre, gross energy, and balances (g/d) of nitrogen and energy were 72.99-79.38, 78.50-83.79, 68.20-79.16, 50.76-83.78, 41.57-62.05, 76.24-79.16, 3.76-4.38 and 448.1-530.1, respectively (Naik et al., 2022b). Indigenous layer ducks could utilize a crude fibre level of 12% without affecting their performance (Anitha et al., 2009).

IMPORTANT ISSUES WITH DUCK FEEDING

Monitoring during feeding of ducks

Under extensive rearing system, it is very difficult to monitor the feeding of ducks. However, duck feeding can only be monitored, if reared under intensive rearing system or while feeding the supplementary feed under semi-intensive rearing system.

Wastage of feed

Wastage of feed is a major concern during feeding of ducks. Ducks are filter feeders and the water escapes through the sides of the bills, retaining the food particles in the mouth. Due to the habits of taking feed & water alternatively, regular cleaning of their bills, dipping of eyes inside water frequently (to prevent from getting scaly and crusty leading to blindness); there is lot of wastage of feeds.

Wetter faeces

Ducks produce wetter droppings, which spoils the feed and water, if not kept properly. Further, it increases the humidity of the duck house and mould growth.

Aflatoxins

Ducks are more sensitive to aflatoxins (Kumar et al., 2022). Mishra et al. (2016) observed aflatoxins levels of 1.3-42.0 ppb in compounded duck feeds. There is significant breed variation in aflatoxin's overall impact on juvenile growth and performances; as there was depression in growth and morbidity, when the aflatoxins B1 exceeded 24 ppb level in diets of White Pekin ducks; but the same was not observed in native breed (Pati), even up to 48 ppb level (Mishra et al., 2019). Aflatoxin B1 at 48 ppb was toxic in the diet of White Pekin ducks as confirmed by reduced growth, increased FCR at 8th week along with adverse effect on haemato-biochemical parameters and histopathological lesions in liver and kidney (Ali et al., 2019a, 2019b). The AFB1 content of juvenile White Pekin ducks should be kept limited to the recommended safe levels (<10 ppb); as when exceeded 200 ppb caused poor growth and FCR, with adverse blood biochemical changes, high mortality, morbidity and lameness (Mishra et al., 2021). Epigenetic adaptation to AFB1 through perinatal ages (till 6 weeks) have conditioned the survivor ducks into superior egg producers; however, such sensitization was better achieved at lower dietary AFB1-doses (24 ppb) than higher (150 ppb) (Mishra et al., 2020). Generally, use of maize and groundnut is avoided in duck feed, as they are more prone for contamination to aflatoxins. Supplementation of bentonite clay @ 2g per kg feed in the feed of White Pekin ducks was helpful in combating the deleterious effects of aflatoxins (Pallavi et al., 2020).

Energy density of the diet

Generally the energy density of the feed is not fulfilled under extensive and semi-intensive rearing systems of ducks. Further, without maize or oil, it is very difficult to fulfil the energy density of the diet under intensive rearing system.

Fishmeal

As ducks are water fowls, they have more inclinations towards aquatic origin animal feed like fishmeal. Replacement of fish meal by soybean meal reduced the performance of Khaki Campbell laying ducks in terms of lower egg production, egg weight, poor FCR and increased cost of egg production; however, the egg quality was improved due to replacement of fish meal by soybean meal with additional lysine and Methionine (Swain et al., 2022d).

Fishy flavour of egg

The trimethylamine (TMA) content in eggs is responsible for the fishy flavour. TMA is found in egg yolk and is a type of biogenic amine that is mainly produced from the choline of feed through microbial action (Wang et al., 2013; Li et al., 2019). Precursors, such as lecithin, betaine, and carnitine, as well as choline-rich food, are degraded into TMA by microorganisms in the intestines of animals (Zeisel et al., 1989; Zhang et al., 1999). After absorption,

TMA is primarily metabolized to its non-odorous trimethylamine N-oxide (TMAO) in the liver by flavin monooxygenase 3 (FMO3) enzymes (Acara et al., 1977). However, FMO3 deficiency leads to decreased or even reduced protease activity, resulting in the inability to oxidize TMA and its accumulation in egg yolk. People perceive a fishy smell, when the TMA concentration is greater than 4 µg/g (Hobson-Frohock et al., 1973; Kubena et al., 1999). The TMA content in chicken egg yolks is 2-3µg/g (Li et al., 2019). The TMA levels in duck eggs (>3.60 ìg/g) were significantly higher than those in chicken eggs (2.35 ìg/g) under normal dietary conditions, and the excessive TMA deposition in duck eggs was one of the main factors causing the fishy odour in duck eggs (Li et al., 2018). In Ducks, there is lower FMO3 enzyme activity than that of other poultry species, so the TMA level is higher in duck eggs (Song et al., 2022). However, the fishy flavour of eggs has mixed response from the consumers; as many consumers like it, while others dislike. Addition of choline in duck diets was responsible for inducing and increase in the TMA content in duck eggs (Li et al., 2018). Feeding ducks a high-level choline diet (containing 4000 mg/ kg choline chloride) leads to a higher egg yolk TMA level and increases the risk of fishy eggs (Li et al., 2019). Choline chloride is rapidly absorbed in the duodenum and is less accessible for fermentation by TMA producing bacteria (Budowski et al., 1977; Goh et al., 1979). In addition, rape seed meal with higher glucosinolates concentration resulted in higher deposition of TMA in duck egg (Tan et al., 2022). Rearing system may also affect the deposition of TMA in yolk by affecting cecal microbiota diversity and composition. The cage rearing system is potentially a low cost way to reduce the fishy odour of duck eggs, promoting consumer acceptance (Shi et al., 2022a). It is suggested that the fishy flavour of the eggs can be reduced by limiting the inclusion of fish meal at 5% level (Mandal, 2022). However, studies have shown that TMA can reduce the accumulation of plaque and has antibacterial and anti-inflammatory properties (Shi et al., 2022b).

CHALLENGES AND FUTURE RESEARCH

There are many challenges with respect to feeds and feeding of ducks in India. The important challenges are: scarce in scavenging areas and natural feed resources; drying of natural water bodies; excessive use of chemicals in crop fields; inadequate information on nutrient content of various duck feeds; etc. The research carried out on ducks is very limited and more attention should be given on various aspects of duck research. The areas for future nutritional research on ducks should be; development of nutrient requirements for different types of ducks in various management systems; exploration and evaluation of locally available feed ingredients and alternate feed resources to minimise the feed cost; standardization of different area specific low cost duck based integrated farming systems; research on amino acid nutrition; exploration and evaluation of feed supplements and additives to increase the efficiency and performance of the ducks; development feeders and drinkers for duck feeding to minimize feed wastage; development of strategies (nutritional, managemental, therapeutic) to increase the fertility; development of location-specific technological interventions to refine the existing feeding practices; development of low cost comprehensive feeding packages for different types of ducks; study on duck microbiota for exploration of feed efficiency and performance; development of aflatoxins tolerant ducks; nutritional interventions for amelioration of fishy flavour in duck eggs; etc. (Naik et al. 2022f).

CONCLUSIONS

In India, there is ample scope for duck production to meet the demand of egg and meat. The challenges related to duck farming should be clearly understood to chalk out the future research programmes. In the scenario of climate change, various nutritional interventions have important role for sustainable duck production, employment generation and in achieving the nutritional and livelihood security of the people of the country. Efforts should be made at each level so that the research based technologies will be easily accessible to the duck farmers.

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