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Indian Chicken Breeds

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Poultry development has been a household activity in India for a long time. In most developing and underdeveloped countries, indigenous chicken breeds significantly improve rural economies. Indigenous breeds can resist disease and utilize low-quality feeds. Backyard poultry eggs and their meat fetches higher prices than commercial poultry. Although they are associated with poor productivity in terms of the number of eggs laid, most consumers prefer them because of their delicious meat. Low risks and low inputs are significant advantages of indigenous chicken production. Considering the rapid loss of indigenous breeds and strains due to commercial strain and breed replacement, preserving these valuable genetic breed resources is crucial. In the presence of a selective breeding program, backyard or free-range birds could be more productive. In order to prevent their extinction, governments should encourage the conservation and further study of these breeds.

Keywords: Chicken; conservation; delicious meat; indigenous breeds; selective breeding.

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1. INTRODUCTION

Chicken is the most popular poultry worldwide, irrespective of culture and religion. Indigenous breeds of chicken spread worldwide, and over twenty breeds spread across the country. Nineteen breeds register with the National Bureau of Animal Genetic Resources (N.B.A.G.R.). The conservation of indigenous chicken breeds is vital for maintaining the local genetic resources, biodiversity, and sustainability of animal production. As a consequence of natural selection, under scavenging conditions, indigenous breeds are more disease-resistant [2]. They can utilize low-quality feed Farrell, [1] and have a greater tendency to survive than commercial hybrid strains Horst, [3], Sonaiya *et al.,* [4]. Free range and backyard systems of rearing with little or no proper housing are necessary for indigenous chicken production across the country. The rearing of Indigenous chickens has been gaining attention recently due to the high demand for their eggs and meat. It also provides subsidiary income to the farmers and provides household nutritional security to the rural/tribal people. The most important characteristics of native chicken are broodiness, escaping from predators, fighting and disease resistance ability.

2. NATIVE CHICKEN BREEDS

The documented breeds in India are Aseel, Ankleshwar, Danki, Ghagus, Kadaknath, Kalasthi, Miri, Tellicherry, Naked neck, Nicobari, Hansli, Uttara, Harringhata Black, Punjab Brown, and Busra. Besides all these, non-descriptive desi chickens are also present.

2.1 Ankleshwar

The Ankleshwar breed of chicken is native to the Ankleshwar area of the Bharuch and Narmada districts in Gujarat. A free-range backyard is used to rear the chickens for their meat and eggs. The plumage pattern is generally striped or spotted with black tips on golden-yellow feathers. Ankleshwar breed chickens have three alleles not found in any other indigenous chicken breed. An allelic gene variant was detected at loci LEI 155, LEI 174, and HUJ 003 [5]. They can survive on 25-30 grams of grain and have a reasonable feed efficiency [6] There is excellent fertility in this breed. Sexual maturity occurs around 154 days, and fertility and hatchability are 86 percent and 77 percent, respectively [7]. Each year, approximately 80 eggs are produced [8]. These birds are primarily raised by South Gujarat tribal communities for backyard poultry farming.

2.2 Aseel

The Aseel breed of chicken originates from the districts of East Godavari, Vishakhapatnam, and Vizianagaram in Andhra Pradesh. However, these birds are also found in other states, such as Orissa, Madhya Pradesh, and Rajasthan. They are known for their aggressiveness, intelligence, high stamina, majestic gait, and dogged fighting qualities, the Aseel is one of India's most important indigenous chicken breeds [9]. The most popular varieties are peela (golden red), yarkin (black and red), nurie (white), kagar (black), chitta (silver black and white), teekar (brown), and reeza (light red). They are mainly known for the quality of their meat, and they are not as productive [10]. Its meat is known for its pungent flavor, firm texture, low fat, and rich nutritional content [11,12]. Fertility and hatchability of fertile eggs are 66 percent and 63 percent, respectively, at 196 days of age. Approximately 64 eggs are produced by the Aseel breed annually [13].

2.3 Busra

A breed of chicken known as the Busra is reared by tribal people in Maharashtra and Gujarat. Only this breed of backyard poultry contributes significantly to the economy of tribal people in Maharashtra. Its body color varies widely, and it is small in size. They have white plumage with black feathers on the neck and tail and reddish-brown feathers on their shoulders and wings. There is a specific frizzle character to these birds. In general, sexual maturity occurs between the ages of 5-7 months Yadav *et al.,* [8], with an average of around six months. Hatchability varies between 60 and 85 per cent for total egg production [8]. The average number of eggs produced per year is between 40 and 55 [14].

2.4 Chittagong

It is also known as Malay Chicken. In India, it is native to the northeastern states bordering Bangladesh and is the tallest breed. Body size is larger, shoulders are broad, and loins are slightly narrower. Compared to the rest of the breeds, they have taller neck and feet. It has a featherless shank and an upright stance. The annual egg production is between 70 and 120 eggs [15].

Table 1. Representation of the chicken breeds and their home tract

Sr. No.	Name of the breed	Home tract	Sr. No.	Name of the breed	Home tract
1.	Ankleshwar	Gujarat	11.	Kashmir Favorolla	Jammu and Kashmir
2.	Aseel	Chhattisgarh, Odisha and Andhra Pradesh	12.	Miri	Assam
3.	Busra	Gujarat and Maharashtra	13.	Nicobari	Andaman & Nicobar
4.	Chittagong	Meghalaya and Tripura	14.	Punjab Brown	Punjab and Haryana
5.	Danki	Andhra Pradesh	15.	Tellichery	Kerala
6.	Daothigir	Assam	16.	Mewari	Rajasthan
7.	Ghagus	Andhra Pradesh and Karnataka	17.	Kaunayen	Manipur
8.	Harringhata Black	West Bengal	18.	Hansli	Odisha
9.	Kadaknath	Madhya Pradesh	19.	Uttara	Uttarakhand
10.	Kalasthi	Andhra Pradesh			

(Source: N.B.A.G.R. https://nbagr.icar.gov.in/en/new-breeds)

2.5 Danki

The home tract of this breed is in the Vizianagaram, Vishakhapatnam, and Srikakulam districts of Andhra Pradesh. The plumage color of these birds determines what name the locals call them. There are black-colored birds (khaki or sanwla), red-colored birds (dega), brick-colored birds (parla), white-colored birds (satua), and spotted birds (pingle). The fight between these birds is called Danki and hence used for fighting purposes. The fights can last between one and one and a half hours. It is also possible to keep eggs for hatching instead of consuming them. Most birds have brown plumage on their bodies, with a few black feathers on the ventral surface. The appearance of Danki birds is similar to that of Aseel birds. Danki fighting does not involve slashers, but each Aseel bird has its slasher. Sexual maturity occurs between 6 to 8 months of age [8]. Most eggs produced will hatch, with 71.93 percent hatchability [16]. The average annual egg production is around 32 eggs [17].

2.6 Daothigir

The home tract of this breed is the Miri, Kokrajhar, Chirang, Udalguri, and Baska districts of Assam. Mostly, it is reared in backyards or free ranges by the Bodo tribes. The breed's name comes from the plant 'Thigir' (Dillenia indica). The shape of the flower is similar to the comb of these birds. As 'Dao' is a word meaning 'Bird' in the Bodo language, this bird has the name Daothigir [18]. It has a stripped and spotted pattern, black feathers mixed with white feathers, and is tiny in stature but heavy in weight [19]. Approximately 5-8 months is required to attain sexual maturity. There is an 80-85 per cent hatchability rate on total egg production. The average annual egg production is 60-70 eggs [8].

2.7 Ghagus

The Ghagus chicken breed is an essential native chicken breed in India [20]. It is native to the Kolar district in Karnataka, on the border between Andhra Pradesh and Karnataka (Vij *et al.,* 2006). It is a medium-sized bird with strong maternal instincts and brooding behavior. Males of this breed have golden yellow feathers on their necks; their wings and tail feathers are bluish-black. The majority of feathers in female birds are brown [21]. In backyard farming systems, these birds are kept for eggs. It is estimated that sexual maturity occurs between 150 and 180 days [22]. There is a 91.5 percent fertility rate and a 90.8 percent hatchability rate for fertile eggs. The average number of eggs produced per year is 45-60 (Yadav *et al.,* 2017).

2.8 Hansli

Keonjhar and Mayurbhanj in Odisha are home to the Hansli chicken breed. Its plumage color is predominantly black, while its body and breast are dark greys. Despite high ambient

temperatures and humidity, these birds can perform well under low input conditions. It is important to note that birds weigh less andcan fly to protect themselves from predators. According to Behera *et al.* (2017), female birds weighed 1318g, and male birds weighed 1629g at 20 weeks. It takes 6 months for a hen to reach sexual maturity [23]. Most of the eggs produced are hatched and rarely consumed. The average number of eggs produced each year is 50-67.

2.9 Harringhata Black

On of the registered chicken breed is found in Nadia district, West Bengal, in the Harringhata black [24]. Their bodies are small, and they have a black color to them. In both males and females, the plumage color is black. Sexual maturity occurs around 5-6 months of age. A study conducted by Vij *et al*., [25]. projects that yearly flock will lay 98 eggs without brooding and 45 eggs with brooding.

2.10 Kadaknath

The meat of this breed is black, that's why Kadaknath is also called kalamashi. Jhabua and Dhar districts in Madhya Pradesh are the home tract of this breed. Black is the dominant color of all body components in this breed, including blood and flesh. The black color is due to hyperpigmentation caused by the fibro melanosis gene (Fm) [26]. Intellectual Property India Registry, Chennai, has granted Geographical Indication (G.I.) status to this native chicken breed for its black chicken meat. Despite its unattractive appearance, Kadaknath chicken meat is famous for its flavor and taste. In addition to having aphrodisiac properties [27], the meat possesses high levels of protein (25.7 percent) and 18 kinds of essential amino acids, along with vitamins B1, B2, B6, B12, and C. A significant number of genes have been recognized in the Kadaknath chicken breeds, which improve high-yielding exotic germplasm, tropical adaptability, and disease resistance. Sexual maturity occurs between 162 and 200 days, with an average of 185.4 days [27-30]. At 25 to 30 weeks of age, fertility and hatchability are 83.1 percent and 80.2 percent, respectively [31]. The egg production of Kadaknath chicken varies between 93.6 and 105 per year [32].

2.11 Kalasthi

A breed of chicken called Kalasthi comes from the Chittoor district of Andhra Pradesh Mohapatra and Panda [24] and its adjoining areas. The legs of these birds are proportionately longer than their bodies. There are no wattles. Sexual maturity was observed around 6 to 8 months [8]. The hatchability of total egg production was 72.14 percent [5]. A hen will lay around 34 eggs annually (Kalita *et al.,* 2012).

2.12 Kashmir Favorolla

Usually found in Srinagar, Baramulla, Anantnag, Budgam, Kupwara, and Pulwama districts of Jammu and Kashmir. Cold climates are most suitable for this breed. It has a characteristic feather cap (tuft of feathers) and is highly disease resistant and the bird's average egg weight is 46.06 ± 0.48g [33]. These birds are raised for both eggs and meat. It takes around 210 days to reach sexual maturity [34]. On average, 64 percent of eggs hatch. Egg production varies from 60 to 65 eggs a year.

2.13 Kaunayen

It originates from the eastern and western districts of Imphal and Bishnupur in Manipur. As the name implies, Kaunayen combines the words 'Kauna' and 'yen.' 'Kauna' means to 'kick or fight' in the Manipuri language, while 'Yen' means 'hen' or 'poultry'. Due to their fighting characteristics, these birds are called Kaunayen. These birds contribute significantly to the income of poultry owners due to their fighting abilities. At the age of eight months, cocks are trained to fight. These breeds can fight for a more extended period. To reach sexual maturity, a bird will need 5-7 months, Average hatchability is 80 percent and a hen can produce around 35 eggs annually (Vij *et al.,* 2016). The egg production of Kaunayen birds is similar to that of Aseel (Terminal Report 1996-1999) and Danki [19].

2.14 Miri

The Miri tribes of Assam typically raise Miri-type chickens. According to the local name in Assam, it is also called "Porog." These are mainly found in Dhimaji, Lakhimpur, Dibrugarh, and Sibsagar in Assam. The age at sexual maturity is around 147 days [35]. Among the total eggs produced, 87 to 91 percent are fertile and the hatchability percentage is around 41.36 ± 3.56 (Kalita *et al.,* 2012). It lays 60-70 eggs per year (Yadav *et al.,* 2017).

2.15 Mewari

Mewari is originated from Ajmer, Banswara, Bhilwara, Chittorgarh, Dungarpur, Jaipur, Sirohi, Udaipur, Rajsamand districts of Rajasthan. It is mainly used for egg and meat purpose. It's plumage colour is brown with single type comb, yellow colour shank and brown egg shell colour. Mishra *et al.,* [36] reported that the age at first egg was 142 days and age at sexual maturity was 181.82 days. The author also mentined that the egg weight at 28th and 40th week as 36g and 42g and the annual HDEP up to 72 weeks of age as 86 eggs.

2.16 Nicobari

A Nicobari breed of chicken originates from the Nicobar Islands. The Nicobari fowl comes in three varieties: brown, black, and white. With short legs and a stout neck, they have a brownish matte color. When Nicobari fowls reach ten weeks, they have short shanks measuring 3.7 cm [37]. Among all Indian chicken breeds, the Nicobari breed produces the most significant number of eggs [38]. Annual egg production of 169.1 eggs was reported [39].

2.17 Punjab Brown:

Punjab and Haryana are the main breeding regions for this breed. The plumage of this bird is brown. Usually, males have black stripes on their tails, wings, and necks. The birds are reared for egg production as well as meat production. Sexual maturity occurs between 5-6 months of age [34]. On average, 60-80 per cent of the eggs produced will hatch. The average number of eggs produced each year is 60 to 80. Average clutch size in Punjab Brown egg is about 4-5 eggs [8].

2.18 Tellicherry

The Tellicherry breed of chicken is indigenous to the Malabar region of Kerala [40]. This breed gets its name from Tellicherry in the Kannur district of Kerala, found mainly in Calicut. Tellicherry is also known as Thalassery. In general, these birds are raised for their meat. There is a wide variation in plumage color, from black to grey. The eggs are tinted and small to medium (Mohapatra and Panda [24] Acharya and Bhatt [40], Singh and Johari [20]. It is believed that these birds have medicinal properties. They are used to prepare ayurvedic medicines for problems such as anemia, asthma, and worm infestation. The sexual maturity age is between 5-8 months; the hatchability rate is approximately 70-80 percent. A hen will lay an average of 60 to 80 eggs per year.

2.19 Uttara

The Uttara breed was registered in 2018, belonging to the Kumaon region of Uttarakhand that borders Nepal and Tibet [41]. The breed is disease-resistant and can survive well under poor housing, poor management, and poor feeding [41]. The plumage of these birds is black, the shanks are feathered, the skin is white, and the comb is single. Kumar *et al.* [42]. report an annual egg production of about 137 eggs.

3. ADVANTAGES OF INDIGENOUS CHICKEN BREEDS

In conventional backyard farming, these breeds are suitable. In addition to being more resistant to diseases, they consume low-quality feeds. They can adapt to adverse conditions and survive well by scavenging and using the leftover feed. In all cases, indigenous birds with red or white plumage colors with pea-shaped combs command higher prices. There is a marked difference in taste between the meat of these birds and that of broilers. Breeds of indigenous chickens have broodiness character. Additionally, they provide supplemental income for the rural poor and contribute to family nutrition.

4. MAJOR DRAW BACKS OF INDIGENOUS CHICKEN BREEDS

There is usually poor production performance, a small body size, delayed sexual maturity, and high mortality among indigenous breeds. Genetic dispositions and inadequate management practices are responsible for the poor performance of indigenous breeds.

5. CONSERVATION STRATEGIES

Conservation is a positive, embracing, preservation, maintenance, sustainable utilisation, restoration and enhancement of the endangered species those of particularly those of economic, scientific and cultural interest to mankind for agriculture either at present or in the future. Endangered species should be conserved for their possible scientific use and for their potential economic use in the future which

includes use of conservation stocks as control population, in order to monitor and identify advances and changes in the genetic makeup and production characteristics of selected stocks. There also breeds which have been associated with social and cultural development and religious ceremony and also for their aesthetic value.

The three main methods for the conservation of animal genetic resources includes embryos or semen stored cryogenically in liquid nitrogen (-196^{0}C), genetic information as DNA and conservations of live populations. The main conservation techniques are ex-situ conservation, in-situ conservation, gene pool and separate breeds.

There is concern about the genetic resources of chicken breeds being endangered and under-conserved (Hoffman, 2009). Around 33% of the world's chicken breeds are threatened, and another 40% are at unknown risk (FAO, 2007). In sustainable animal breeding segments, indigenous chickens receive much-needed attention due to their unique genetic resources [43]. Creating an inventory of indigenous chicken varieties is necessary for conserving and evaluating their traits for the development of future breeding strategies [44]. It is possible to characterize indigenous chicken breeds using biotechnological approaches such as D.N.A. markers [45]. In a study by Mtileni *et al.* [46], local chicken populations in South Africa and Zimbabwe have a high degree of heterozygosity and many alleles.

Most poultry genetic resources are preserved in situ in the living population. However, this method has difficulties, including pathogen epidemics, genetic problems, and natural disasters. Chicken semen mainly goes into ex-situ preservation on industrial chicken farms. Nevertheless, indigenous breeds are preserved as in-situ populations. Ex-situ conservation practices are crucial for maintaining genetic diversity in domestic animals, complementing in situ efforts. Gene banks play a vital role in safeguarding genetic diversity against selection and genetic drift, and their importance is growing, especially in poultry breeds, due to advances in reproductive technologies. Stakeholders are encouraged to utilize gene banks to store genetic material, which is especially important for local breeds at risk of conservation failure without proper management and molecular data support. Because of advancements in reproductive biotechnologies and efforts to maximize the use and exploitation of genetic collections, there has been a growing interest in cryopreservation over the years for local animal breeds, particularly chicken [47]. The National Center for Conservation and the evaluation center will maintain the breed/ecotype in living form. Embryos, D.N.A., and tissue samples will be cryopreserved for ex-situ conservation. In traditional poultry production systems, improving a few important indigenous breeds is crucial to ensure their sustainable production. The native germplasm of backyard poultry is excellently suited for poultry production. It is intended that the improved germplasm will be distributed to the respective state governments for replication and distribution in their home territories for backyard poultry production. Conservation will take place in their natural habitats. These breeds will provide a source of variation for future improvements in poultry. The establishment of a National Center for Avian Genetic Resources would be a desirable idea. The Food and Agriculture Organization of the United Nations has initiated a program to characterize and conserve indigenous breeds to preserve their genetic material (Rischkowsky and Pilling, 2007). Breeds such as Naked Neck, Ovambo, Potchefstroom, and Venda are part of the South African Agricultural Research Council's genetic improvement and conservation program (Mtileni et al., 2016).

All breeds and strains with minor variations are candidates for conservation for academic and scientific reasons. It will be necessary to distinguish between breeds based on the cost of infrastructure facilities involved in conservation. The National Bureau of Animal Genetic Resources is responsible for this in India. The conservation process is expensive and requires planning, funding, and follow-up. An Avian Resource Genetic Task Force (A.G.R.T.F.), composed of members from national institutions, state governments, state agriculture universities, commercial breeders, and fancy breeders, should be established to plan conservation strategies. Depending on the genetic diversity and existence of any particular genes, a breed/ecotype may be recommended for conservation by AGTRG/SAC. The initial phase in preserving genetic diversity involves capturing as much as variation as possible within the foundational nucleus. This ensures a rich genetic base for future generations. The second step in a conservation program involves genetic screening of the initial group. This is crucial to identify genetic risks such as low diversity, high

inbreeding, and harmful alleles. To reduce these risks, the most widely adopted method is to minimize average kinship among individuals in the program [48]. Introducing genetic material from individuals of the same breed can be an effective strategy to counteract the loss of genetic diversity and the rise in genomic inbreeding. Utilizing high-throughput sequencing data can inform this process by offering insights into the functional significance of genetic variants that are typically overlooked. This approach can help maintain the health and viability of the breed [49]. The main aim of a conservation program is to preserve extensive genetic diversity and regulate inbreeding. This strategy helps to ensure that populations can adapt to new breeding objectives over time and maintain their vitality. In essence, it's about safeguarding the genetic health and adaptability of populations for the future [50-54].

6. PRESENT STATUS OF EVALUATION AND CONSERVATION

Aseel (Peela and Kagar), Kadaknath, Ankleshwar, Naked Neck, and Frizzled ecotypes at C.A.R.I., Izatnagar [55-58]. Nicobari breeds are assessed and conserved at ICAR-Central Agricultural Research Institute, Port Blair. Several breeds are being assessed at the N.B.A.G.R., Karnal, through field surveys and network projects, but flocks are not being kept [59-61]. Madhya Pradesh's Animal Husbandry department also maintains a random-bred population of Kadaknath and Aseel at Jhabua and Jagdalpur hatcheries [62,63].

7. CONCLUSIONS

Native chicken breeds provide a significant source of income for rural poor and marginalized populations. Furthermore, it provides them with nutritious chicken eggs and meat. Despite challenging environmental conditions and poor husbandry practices, these breeds can produce well without much loss in production. Selective breeding can improve the productivity of indigenous chickens raised in free-range or backyards. The production of indigenous chickens can be increased through various breeding techniques to conserve their natural habitats. Governments need to support the conservation of these breeds to prevent their extinction and conduct further studies to prevent their extinction. The development and implementation of conservation techniques and genetic enhancement can be coordinated in a coordinated approach.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Farrell DJ. Strategies for improving the production of scavenging chickens. Asian-Austral. J. Anim. Sci. 2000; 100:79-82.
2. Minga UM, Msoffe PL, Gwakisa PS. Biodiversity (variation) in disease resistance and in pathogens within rural chicken populations. In International Health Network for Family Poultry (I.N.F.D.). World Poultry Congress. 2004;8-13.
3. Horst P. Native fowl as a reservoir for genomes and major genes with direct and indirect effects on productive adaptability. Proc. 18th World's Poultry Congress Japan. 1988;99-104.
4. Sonaiya EB, Branckaert RDS, Gueye EF. Research and development options for family poultry. *First INFPD/FAO* Electronic Conference on Family Poultry. December 7 1998 – March 5. Introductory paper; 1999.
5. Vij PK, Tantia MS, Mishra B, Kumar SB, Vijh RK. Characterization of Aseel, Danki, Kalasthi and Ghagus breeds of chicken. Indian J. Anim. Sci. 2006;76(11): 944-49.
6. Pandey AK, Kumar D, Sharma R, Sharma U, Vijh RK Ahlawat SPS. Population structure and genetic bottleneck analysis of Ankleshwar poultry breed by microsatellite markers. Asian-Austral. J. Anim. Sci. 2005;18(7):915-921.
7. Patel AB, Bhagora NJ, Savaliya FP, Mishra RK, Lonkar VD. Performance of Ankleshwar chicken reared under intensive management system in Gujarat. Indian J. Vet. Sci. Biotechnol. 2020;15(4):47-50.
8. Yadav AK, Singh J, Yadav SK. Characteristic features of indigenous poultry breeds of India: A review. Int. J. Pure Appl. Biosci. 2017;5(1):884-892.
9. Singh DP. Aseel of India. In: Souvenir, National Seminar on Appropriate Poultry for Adverse Environment. Organized by Acharya N G Ranga Agricultural University and Project Directorate on Poultry, Hyderabad; 2001.
10. Rajkumar U, Muthukumar M, Haunshi S, Niranjan M, Raju MVLN, Rama Rao SV, Chatterjee RN. Comparative evaluation of carcass traits and meat quality in native Aseel chickens and commercial

broilers. Br. Poult. Sci. 2016;57(3):339-47.
11. Zhao GP, Chen JL, Zheng MQ, Wen J, Zhang Y. Correlated responses to selection for increased intramuscular fat in a Chinese quality chicken line. Poul. Sci. 2007;86(11): 2309-14.
12. Chen JL, Zhao GP, Zheng MQ, Wen J, Yang N. Estimation of genetic parameters for contents of intra muscular fat and inosine -5 –monophosphate and carcass traits in Chinese Beijing –You chickens. Poult. Sci. J. 2008;87(6):1098–1104.
13. Rajkumar U, Haunshi S, Paswan C, Raju MVLN, Rao SR, Chatterjee RN. Characterization of indigenous Aseel chicken breed for morphological, growth, production, and meat composition traits from India. Poult. Sci. 2017;96(7):2120-2126.
14. Vij PK, Tantia MS, Vijh RK. Phenotypic and genetic characteristics of Busra breed of chicken. Indian Vet. J. 2009;86(8):864-866.
15. Kumar S, Rahim A. Status of poultry genetics resources, conservation, strategies, and breeding policies for their improvement in India, excerpted from 'International Symposium on Sustainable Management of Animal Genetic Resources for Livelihood Security in Developing Countries & XII Annual Convention of Society for Conservation of Domestic Animal Biodiversity. 2015;226-34.
16. Vij PK, Tantia MS, Vijh, RK, Nahardeka N, Ahlawat SPS. Chicken breeds of India-Daothigir. Leaflet 35, National Bureau of Animal Genetics Resources PO Box 129, Karnal. 2006;132001.
17. Kalita N, Islam R, Pathak N, Chutia H. Hatchability and mortality of indigenous chicken in Assam. Indian Vet. J. 2012;89 (5):35.
18. Kalita N, Talukdar A, Borah MK. A study on the performance of the Daothigir breed of chicken under intensive system of management in Assam. 2021;9(1):1753-55.
19. Vijh RK, Chatterjee RN, Vij PK, Tantia MS, Ahlawat SPS. 2006. Chicken Breeds of India-Ankleshwar. National Bureau of Animal Genetics Resources, PO Box 129, Karnal 132001.
20. Singh D P, Johari D C. Conservation and management of poultry genetic resources of India. The Indian Journal of Animal Breeding and Genetics. 2000;22: 195-205.
21. Haunshi S, Arun Kumar B, Kannaki TR, Rajkumar U. Survivability, immunity, growth and production traits in indigenous and white leghorn breeds of chicken. Br. Poult. Sci. 2019a; 60(6):683–690.
22. Thiruvenkadan AK. Production of hybrid layer and broiler stock. Proceedings of the training programme on Nutritional and managemental strategies to exploit the genetic potential of hybrid poultry, Namakkal, India. 2012;141-148.
23. Mohapatra SC, Mishra SC, Kornel D. Indigenous poultry genetic resources in Orissa, Inter Cooperation Natural Resource Management Rural Economy, Local Governance and Civil Society, Swiss Agency for Development and Cooperation. 2006;1-9.
24. Mohapatra SC, Panda B. Poultry genetic resources of India. Poultry Industry Yearbook. 1981;50-58.
25. Vij PK, Tantia MS, Pan S. Performance of harringhata black chicken under field conditions. Indian J. Anim. Sci. 2015;85(8): 930-932.
26. Arora G, Mishra SK, Nautiyal B, Pratap SO, Gupta A, Beura CK, Singh DP. Genetics of hyperpigmentation associated with the Fibromelanosis gene (Fm) and analysis of growth and meat quality traits in crosses of native Indian Kadaknath chickens and non-indigenous breeds. Br. Poult. Sci. 2011;52(6):675-85.
27. Mohan J, Sastry KVH, Moudgal RP, Tyagi JS. Performance profile of Kadakanath desi hens under normal rearing system. Indian J. Poult. Sci. 2008;43(3): 379-81.
28. Haunshi S, Niranjan M, Shanmugam M, Padhi MK, Reddy MR, Sunitha R, Rajkumar U, Panda A K. Characterization of two Indian native chicken breeds for production, egg and semen quality, and welfare traits. Poult. Sci. 2011;90(2):314-20.
29. Jha DK, Prasad S, Soren SK, Bharti A. Production performance of indigenous chicken in intensive farming system. Indian J. Poult. Sci. 2013;48(1):105-08.
30. Yadav SK, Maurya SK, Yadav AK, Yadav K, Singh KD. Polymorphism of Prolactin gene in relation to egg production performance in Kadaknath hens. Indian J. Anim. Res. 2018;52(2): 208-211.
31. Biswas A, Mohan J, Sastry K V H. Effect of higher dietary vitamin E concentrations on physical and biochemical characteristics of

Semen in Kadaknath cockerels. Br. Poult. Sci. 2009;50(6):733-38.

32. Singh DP, Prasad S. Egg production curves of Kadaknath and its crosses with C.A.R.I. Red. In Proceedings of 23rd Annual Conference and National Symposium of Indian Poultry Science Association, Hyderabad. 2005;203.
33. Rather MA, Shanaz S, Ganai NA, Hamadani A. Status of farm animal genetic resources of Jammu and Kashmir-A Review. Int. J. Livest. Res. 2020;10(4):27.
34. Vijh RK, Chatterjee RN, Vij PK, Tantia MS, Ahlawat SPS. 2005. Chicken Breeds of India-Kashmir Favrolla. National Bureau of Animal Genetics Resources, PO Box 129, Karnal 132001.
35. Haunshi S, Doley S, Shakuntala I. Production performance of indigenous chicken of northeastern region and improved varieties developed for backyard farming. Indian J. Anim. Sci. 2009;79(9): 901.
36. Mishra S, Chatterjee RN, Haunshi S, Rajkumar U. Characterization of Mewari, an indigenous chicken breed, from hot tropical climate of India. Indian J. Anim. Sci. 2022;92(12):1408-1414.
37. Chatterjee RN, Yadav SP. Farming system of Nicobari fowl–an endangered breed of Andaman and Nicobar Islands, India. World's Poult. Sci. J. 2008;64(2): 245-56.
38. Ahlawat SPS, Chatterjee RN. Conservation of indigenous poultry germplasm of A and N Islands. In Proceedings of National Workshop on Characterization and Conservation of Indigenous Poultry Germplasm. 2002;9-14.
39. Haunshi S, Padhi MK, Rajkumar U. Improvement of PD-4 (Aseel), an Indigenous Chicken Breed for Growth and Production Performance. Indian J. Anim. Sci. 2019b;89(4):419–423.
40. Acharya RM, Bhat PN. Livestock and poultry genetic resources in India. Research Bulletin No.1 IVRI, Izatnagar, Uttar Pradesh; 1984.
41. Singh MK, Kumar S, Sharma RK, Singh SK, Singh B, Singh DV. Assessment of pre-and post-incubation parameters in Uttara breeder hens. Indian J. Anim. Res. 2017;51(5):948-951.
42. Kumar S, Sharma R K, Kumar A. Documentation and conservation of indigenous poultry germplasm with special reference to Uttara. Proceedings of 35th Annual Conference of Indian Poultry Science Association, Port Blair. 2018;42-46.
43. Al-Qamashoui B, Simianer H, Kadim I, Weigend S. Assessment of genetic diversity and conservation priority of Omani local chickens using microsatellite markers. Trop. Anim. Health Prod. 2014; 46:747-752.
44. Solis A, Jugo BM, Meriaux JC, Iriondo M, Mazon LI, Aguirre AI, Vicario A, Estomba A. Genetic diversity within and among four South European native horse breeds based on microsatellite D.N.A. analysis: implications for conservation. J Hered. 2005;96(6):670-678.
45. Mtileni B J, Muchadeyi F C, Maiwashe A, Chimonyo M, Groeneveld E, Weigend S, Dzama K. Diversity and origin of South African chickens. Poult. Sci. 2011;90(10): 2189-94.
46. Mtileni B, Dzama K, Nephawe K, Rhode C. Estimates of effective population size and inbreeding in South African indigenous chicken populations: Implications for the conservation of unique genetic resources. Trop. Anim. Health Prod. 2016;48:943-50.
47. Blesbois E, Seigneurin F, Grasseau I, Limouzin C, Besnard J, Gourichon D, Coquerelle G, Rault P, Tixier-Boichard M. Semen cryopreservation for ex situ management of genetic diversity in chicken: creation of the French avian cryobank. Poult. Sci. 2007;86(3): 555-564.
48. Caballero A, Toro MA. Interrelations between effective population size and other pedigree tools for the management of conserved populations. Genet. Res. 2000;75(3):331-343.
49. Van Oosterhout C, Speak SA, Birley T, Bortoluzzi C, Percival-Alwyn L, Urban LH, Groombridge JJ, Segelbacher G, Morales HE. Genomic erosion in the assessment of species extinction risk and recovery potential. BioRxiv. 2022;2022-09.
50. De Cara MAR, Villanueva B, Toro MA, Fernandez J. Purging deleterious mutations in conservation programmes: combining optimal contributions with inbred matings. Heredity. 2013;110:530-537.
51. Behera D, Pradhan CR, Behura NC, Mohapatra LM, Mohanty GP, Behera K, Das DP, Sahu RK. Production performance

of Hansli chicken in Odisha. J. Entomol. Zool. Stud. 2017;5(6):1219-24.
52. FAO. Global plan of action for animal genetic resources and the Interlaken declaration. In- Proceedings of the International Technical Conference on Animal Genetic Resources for Food and Agriculture, Interlaken, Switzerland, 3–7 September 2007. Rome, Italy: FAO; 2007.
53. Faruque S, Siddiquee N U, Afroz M A, Islam M S. Phenotypic characterization of Native Chicken reared under intensive management system. J. Bangladesh Agril. Univ. 2010;8(1):79-82.
54. Grobbelaar JAN, Sutherland B, Molalakgotla NM. Egg production potentials of certain indigenous chicken breeds from South Africa. Animal Genetic Resources/Resources génétiques Animales/Recursos Geneticos Animals. 2010;46:25-32.
55. Hoffmann I. Open questions on poultry genetic diversity. In *World Poultry Science* Association (WPSA), 6th European Poultry Genetics Symposium, Bedlewo, Poland. 2009;61-73.
56. Lin H, Jiao H C, Buyse J, Decuypere E. Strategies for preventing heat stress in poultry. World's Poult. Sci. J. 2006;62(1): 71-86.
57. NBAGR. National Bureau of Animal Genetic Resources, Karnal-132001 Haryana, India. Available:https://nbagr.icar.gov.in/en/new-breeds
58. Rischkowsky B, Pilling D. The state of the world's animal genetic resources for food and agriculture. Food and Agriculture Organization, Rome; 2000.
59. Singh R, Singh DP. Poultry genetic resources of India and their role in future poultry production. Chapter 26. Domestic Animal Biodiversity–Conservation and Sustainable Management, R. Sahai and RK Vijh (Eds). S.I. Publications, Karnal. 2006;256-262.
60. Terminal Report. Network Project on Survey of Poultry (Aseel) Genetic Resources. Department of Animal Breeding and Genetics, I.G.K.V.V, Anjora, Durg (M.P.);1996–99.
61. Vij PK, Tantia MS, Singh TR. Kaunayen chicken-a new indigenous germplasm from Manipur. Indian J. Anim. Sci. 2016;86(9): 1085-1087.
62. Vijh RK, Chatterjee RN, Vij PK, Tantia MS, Ahlawat SPS. Chicken Breeds of India-Punjab Brown. National Bureau of Animal Genetics Resources, PO Box 129, Karnal 132001; 2005.
63. Yakubu A, Ogah DM, Barde RE. Productivity and egg quality characteristics of free-range naked neck and normal feathered Nigerian indigenous chickens. Int. J. Poult. Sci. 2008;7(6):579-85.

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