



THE UNIQUENESS OF IMMUNOCOMPETENCE AND MEAT QUALITY OF NATIVE CHICKENS: A SPECIALIZED REVIEW

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ABSTRACT

Native breeds of chicken have been reported in various countries like India, Thailand, Taiwan, Japan, Korea, Turkey, China etc. They possess certain distinctive qualities that includes high immunocompetence and better meat quality compared to commercial broilers. In the recent years there is an increasing trend in consumer and farmer preference to native chickens due to the better taste and flavor of meat and eggs and higher disease resistance. Certain breeds of native chicken of various countries, their features and unique qualities in terms of immune potential and meat quality are discussed.

KEY WORDS: Native chicken; immunity; meat quality.

INTRODUCTION

Chickens are the most popular amongst different poultry species worldwide ^[1]. Owing to their relatively low fat and cholesterol contents than other meat, chicken meat is considered as a healthy animal food^[2]. Moreover, chicken continues to be the cheapest among all types of meat consumed in the world and its consumption is expected to increase by 34% by 2018 ^[3]. Archeological studies indicate that chicken had been domesticated by 5400 BC. The chickens kept by the Harappan Culture of the Indus Valley are considered as the main source for subsequent global dispersal of domestic animals. It is hypothesized that chickens were originally utilized primarily for religious ceremonies and sporting purposes and, in fact, eating chicken was likely taboo in many cultures and later they were utilized as a source of human food ^[4,5]. The commercial poultry industry has developed into huge industry in the last eighty years. This was made possible by genetic selection and breeding of poultry for

commercial traits. Conservation of animal genetic resources is essential to sustain and increase the quality of life on earth. Unfortunately, an increase in the loss of animal genetic resources is being reported for all agriculturally important species. Among such species, poultry are the most endangered one and these effects are more severe in developing than developed countries. One of the major reasons for this scenario is the commercial poultry industry which led to the disappearance of less productive local breeds^[6]. However, in the recent years native chickens are getting attention in various countries. This is because of unique hardiness of the breeds, their ability to thrive under adverse climatic conditions and the desirable taste and flavor of eggs and meat. Reports from China^[7], Thailand^[8], Italy^[9], Taiwan^[10] and Korea^[3,11] have indicated a preference of consumer to native chickens. Therefore this article is aimed to review the published information on native chickens of various countries.

NATIVE CHICKEN BREEDS OF VARIOUS COUNTRIES

Native breeds of chicken have been reported in various countries like India, Thailand, Taiwan, Japan, Korea, Turkey, China etc. Some of the common features of native chickens are that they don't need any special structures of housing and can stay on rooftops, walls, tree branches etc. Most of the times, they get their feed by scavenging in the nearby areas and can effectively utilize low quality feeds. The hardiness of the breeds and the specialized meat quality make them a choice of earning for rural women.

There are approximately fifty breeds of native chickens in Japan and they are divided into two groups namely Japanese fancy fowl and Japanese utility fowl. Japanese fancy fowl are commonly used for hobby whereas the Japanese utility fowl are used for egg and/or meat production. These Japanese breeds are reviewed in detail by Tsudzuki^[12]. Thai native chickens are maintained by about fifty percent of Thai people. As the people of Thai consider the native chicken meat tastier and as well as healthier than broiler meat, the demand for Thai native chickens are higher than supply. Further, the native chickens are shown to possess disease resistance, tolerance to heat stress, and good maternal ability and such characteristics are found to be heritable^[13]. Indian native chickens are usually maintained as backyard poultry. Among various Indian native chicken breeds, the production and reproduction characteristics of Kadaknath and Aseel birds have been documented by Haunshi et al.^[14-16]. The body weight of Aseel birds were $1872.4 \pm 38.4\text{g}$ and $1303.2 \pm 20.1\text{g}$ for male and female respectively at 20 weeks of age. Higher body weight, yolk index, yolk percentage, Yolk-

albumen ratio, sperm concentration, live sperm counts and semen appearance scores were observed in Aseel breed compared to Kadaknath chicken, the other important Indian native chicken breed. Taiwan Country chickens exhibited certain unique characteristics, such as a large and erected comb and heavy fleshy legs. Compared with the commercial broiler and White Leghorn, the Taiwan Country chicken showed better resistance against heat stress and many diseases, and their eggs and meat possess better eating qualities^[17]. The genetic diversity of Chinese native chicken breeds is abundant, and has contributed a lot to the world poultry industry. There are sixty native chicken breeds in China^[18]. The studies on Korean native chickens have reported more active behavioral characteristics for Korean native chicken compared to commercial broilers, especially for walking, preening and pecking behavior. Chickens with such active behavior have been opined to have lesser tendencies to develop potential health problems like dermatitis or even diseases like sudden death syndrome^[19].

The physical characteristics of native chicken of different countries shown variations and certain breeds of native chicken and their physical characteristics are given in Table 1.

Table 1 Physical characteristics of native chicken

Breed of native chicken	Country	Physical characteristics
Izumo, Kumamoto Mikawa, Nagoya, Tosa-Kukin (Japanese Utility Fowl)	Japan	Mikawa has a dubbed comb and buff colored plumage. Nagoya has brown feathers in body and black feather in tail whereas Tosa-kukin possess brownish black tail feathers ^[12,20] .
Taiwan Country chickens	Taiwan	Possess certain unique characteristics, such as a large and erected comb and heavy fleshy legs ^[17] .
Korean native Chicken- Red Brown, Ogol and Yellow Brown	Korea	Chickens are identified by their respective plumage colours, red brown and yellow brown. The feather, meat and bones of Ogol breed are black in colour ^[21] .
Kadaknath	India	Day-old chicks are bluish to black in colour and have irregular dark stripes over the back and adult plumage varies from silver and gold-spangled to bluish-black without any spangling. The skin, beak, shanks, toes and soles of feet are slate like in colour. The comb, wattles and tongue are purple and is known for its black-colored meat ^[22,23] .
Aseel	India	Recognized for its stamina, pugnacity, majestic gait, and dogged fighting qualities. Eight varieties exist but Aseel (Yellow) and Aseel (Black) varieties are commonly available ^[14-16, 22,23]
Danki	India	Plumage colour is predominantly brown; Pea comb is red and compressed; is a fighter breed ^[22,23]

Kalasthi	India	The common plumage colour is bluish black with comb is red and pea type. Reared mainly for meat ^[14-16, 22,23] .
Ghagus	India	The plumage colour is mainly brown, followed by black. Wattles are absent. Comb is red and pea or single type. Spur is short in cocks. Bred mainly for eggs ^[22,23] .
Desi (ND), Hilly (H) and Naked Neck	Bangladesh	All are single combed. Predominant plumage colour of three types of native chickens are black brown (33.33%) followed by white with black tips (28.33%) and red brown (18.3). Hilly birds are covered with plumage of white with black tips (85%) followed by multicolour (15%). Naked Neck birds are very colourful-black brownish, multicolour, red brownish and black feather combinations ^[24] .
Denizli and Gerze	Turkey	Denizli are reared for eggs and are famous for their long crowing. Gerze chickens are primarily reared for eggs ^[25] .
Xianju Chickens	China	Xianju Chickens are light sized layer breed with yellow, beak-yellow and shank yellow plumage ^[26,27] .
Taihe Silkies	China	Light sized breed used in medicine ^[27] .
Chahua Chicken, Tibetan Chicken,		Light sized dual purpose breed (meat and egg) ^[27] .
Baier Chicken		Light sized layer breed with white earlobe ^[27] .
Xiaoshan Chicken, Huainan Partridge, Xiaoshan chicken, Dagu chicken		Heavy sized dual purpose breed (meat and egg) ^[27] .
Gushi chicken		Medium sized dual purpose breed (meat and egg) ^[27] .
Thai Native chickens- Kai Oo, Kai Jae, and Kai Tapao	Thailand	They possess red earlobes, rose-and-pea combs, black and yellow shanks. Their plumage color varies from white to dark blue and from barred to non-barred. Have traits of fighting cocks including strong and tough muscles ^[28] .

UNIQUE FEATURES OF NATIVE CHICKENS THAT ARE OF IMPORTANCE

Native chickens have certain unique characteristics that are of importance in poultry. They have high immunocompetence and better meat quality compared to commercial broilers. Consumer and farmer preference to native chickens due to the better taste and flavor of meat and eggs and higher disease resistance compared to commercial broilers has been reported in various countries^[8-10].

IMMUNE POTENTIAL

The health of poultry is always under threat from various pathogens particularly bacteria and viruses. Hence, resistance to infections is one of the most important quality desired by

commercial industry. However, extensive breeding and selection programmes that carried out to exploit the economic traits in commercial poultry have led to a compromise in the innate immune competence of commercial birds in comparison to their native counterparts. Improved immune defense in livestock may help to reduce the problem of drug resistance in farm animals which in turn may reduce antibiotic residues in animal products. Therefore there is wide interest in improving the innate resistance of commercial flocks by searching for a better germplasm^[29].

Toll-like receptors (TLRs) are members of cellular receptors that belong to the innate immune system. They recognize molecular patterns known as "Pathogen associated molecular patterns (PAMPs) which are unique to microbes namely, lipopolysaccharide (LPS), double stranded RNA, flagellin, lipoteichoic acid (LTA) etc^[30]. TLRs are expressed in a wide variety of tissues and cell types, such as macrophages, monocytes, dendritic cells, B and T cells, mast cells, NTK, neutrophils, eosinophils, fibroblasts, intestinal epithelium, endothelium of veins, smooth muscle cells, etc.. More specifically, TLRs are present in the organs that are involved in the immune responses and in the tissues that are generally exposed to pathogens, including skin, respiratory tract, intestinal and genitourinary tracts, bladder, kidney, spleen and thymus^[31]. During a pathogen entry, different members of TLRs recognize and induce a wide range of responses including cell proliferation and production of various cytokines, chemokines or effector molecules. This in turn leads to their subsequent processing and removal by the immune system. Among various TLRs, TLR-4 which mainly binds with the lipopolysaccharide component of gram negative bacteria and TLR-5 that binds to the flagella of both gram negative and gram positive bacteria are observed in high levels in Indian Aseel and Kadaknath breeds when compared to commercial broilers^[32]. The higher levels of immunity observed in indigenous chickens may be correlated to such an increased TLR mRNAs expression.

Nitric oxide is produced by the macrophages through activation of the inducible enzyme, nitric oxide synthase^[33] and it has antiviral properties^[34]. The expression of inducible nitric oxide synthase (iNOS) gene in chicken macrophages is under genetic control and associated with toll-like receptor-4 expression^[35]. In a study by Kannaki et al.^[36], male Kadaknath birds expressed significantly higher levels of TLR4 and TLR 5 mRNA expression and higher allele B frequency in inducible nitric oxide synthase gene than their Aseel counterparts. Peripheral blood mononuclear cells isolated from Kadaknath breeds exhibited higher constitutive

expression of ch-TLR, ch-TLR 15 and ch-TLR 21 genes, indicating a higher innate immune competence in comparison to Aseel chicks^[30].

High levels of resistance in indigenous chickens over commercial broilers are well documented. For instance, during an *Eimeria tenella* challenge at 12 days of age, the Taiwan Country chickens exhibited higher resistance than broilers^[37]. The extent of resistance was documented in terms of body weight gain, haemoglobin, cecal lesions\ score and cecal oocyst number. As coccidiosis is one of the most dreadful diseases that cause both health and economic losses in poultry, the resistance potential of Taiwan Country chickens needs to be further studied and exploited. In another study conducted by Chao and Lee^[38], Taiwan Country chicken exhibited higher antibody titer responses to Newcastle disease vaccine (B1 and Lasota strains and inactivated alumina-gel virus) and sheep red blood cells than Single Comb White Leghorn birds. Besides bacterial and viral diseases, Taiwan Country chickens are highly resistant to Leucocytozoonosis, a common protozoan disease in Asian countries^[39].

MEAT QUALITY AND SENSORY CHARACTERISTICS

The meat of native breeds of chicken have low fat, high protein and water holding capacity (alternative “healthy meat”) with desirable taste and flavour and fetches higher price than commercial broilers. They are also considered as an alternative for consumers preferring low fat meat.

Meat of Indian Kadaknath chicken is not attractive and is black in color. But the meat has a high percentage of 25.47% of proteins^[40], has a delicious flavor, taste and Kadaknath meat scores better than Aseel breed. The Taiwan country chicken was found to have 11 times more phosphoserine^[41] and better eating quality in terms of higher shear value, better cohesiveness, and tenderness than broilers^[42]. The protein, lipid and ash content of Italian native chicken (Padovana breed) were higher than Thai native chickens or commercial broilers^[8,43]. The meat of Thai chickens exhibited higher shear force, collagen content (thigh only), high proportions of n-3 fatty acids and a favorably low n-6/n-3 fatty acid ratio compared with imported breeds^[2]. Thai native chicken has a unique taste, tough and strong muscles and has a firmer texture and more flavor than the commercial broilers^[8]. To understand the genetic control of meat quality in Thai native chickens, Mekchay et al.^[44] studied the transcriptional gene profiling of both chicken breeds. The study revealed a differential expression of genes

between Thai native chicken and commercial broilers. However, the specific genes have not been identified.

Korean native chickens are found to contain more essential fatty acids and total collagen and desirable amino acids, nucleic acids in addition to better taste and flavor^[45-47]. Korean native chickens are less fatty and have higher protein content compared to foreign breeds^[21]. The proteomic profile of thigh and breast muscles of Korean native chickens are different from that of commercial broilers, indicating the molecular mechanisms responsible for the difference in sensory characteristics of Korean native chickens and broilers^[11]. Further, the concentrations of inosine-5'-monophosphate (IMP) in Korean native chicken and Hinai-jidori chicken meat were higher than those in broilers^[48]. Higher muscle inosine monophosphate (IMP) content was related to meat quality^[11,49] and the single nucleotide polymorphisms (SNPs) in three genes, glutamine-PRPP amino transferase, aminoimidazole ribonucleotide carboxylase and ATIC:IMP cyclohydrolase genes has significant effect on the muscle IMP content in Baier chickens^[50]. In Hinai-jidori chickens, a cross between Hinai-dori breed of Japan and Rhode Island Red breeds the arachidonic content of meat was higher than broilers^[48]. Further supplementation of arachidonic acid was found to increase the arachidonic acid content of thigh meat and were more palatable for humans than broilers during a sensory evaluation carried out by Kiyohara et al.^[20]. Like other native breeds, Chinese native chickens exhibited good meat quality than commercial broilers. The meat exhibited lower shear force value and were superior in myoiber diameter than commercial broilers^[51].

Growth of muscle tissue directly affects the quality of chicken. Growth and development is closely related to molecular metabolism and cellular proliferation. Microarray analysis of muscle tissues of two and twelve weeks old Rugao chicken, the native breeds of China, revealed 208 differentially expressed genes^[52]. The findings indicated that enolase 1 and cyclin B2 (CCNB2) are involved in growth and development of chicken muscle. In addition, an increased expression of RNA polymerase I polypeptide B (POLR1B) and Proteasome subunit, alpha type, 7 (PSMA7), that are important in the molecular metabolism of chicken were observed in 12 weeks old Rugao chicken muscle compared to two weeks old birds. Besides the above, an increased expression of genes related to cell proliferation and differentiation, namely ferritin heavy peptide factor (FTH1), tumor necrosis factor (TNFSF15) were observed.

PRODUCTION POTENTIAL OF NATIVE CHICKENS

In spite of high immunocompetence and desired meat quality, the native chickens are overlooked because of their low production potential. The low body weight and feed conversion efficiency in native chickens over the broilers has been well documented^[8,17] and is considered as a major drawback with these chickens. The digestive and absorptive systems of birds have been suggested to contribute to the differences in growth between the heavy and light-chick strains^[53]. In inducing growth during the early post hatch period, the digestive tract plays a major role and the growth rate of small intestine is thrice that of the whole body^[54]. Scanning electron microscopic studies of parts of digestive system of native chickens and broilers by Wahyuni and Roxas^[55] revealed the presence of microorganisms comprising of microbes of normal microflora in lieum of native chickens by 21 days of age and as early as 7 days in broilers. Further, the small intestinal villi of broiler chicks were observed to have more capacity to enlarge their absorptive surface areas compared to native chickens. Such differences in the development of intestinal absorptive surfaces of native chickens were in line with the growth capacity of each strains respectively.

CONCLUSION

The unique characteristics of native chicken of various countries are well established by research findings. Hence it is essential to conserve the precious genetic resources and every effort from the government and the public needs to be taken to conserve them for the present and future. On the other hand, newer genomic tools could be applied to utilize the potential of native chickens for the betterment of mankind.

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