

Article

First Evidence of Breed-Specific Immune Traits in Local Italian Poultry Breeds

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Abstract

The aim of this study was to provide the first characterization of selected components of innate immunity (lysozyme and complement component C3) and adaptive humoral immunity (immunoglobulin Y) in seven Italian autochthonous chicken breeds and two turkey breeds. A total of 70 chickens (10 animals per breed) and 20 turkeys (10 animals per breed), equally distributed by sex, were sampled. The concentrations of immune traits were determined using avian-specific ELISA kits. In chickens, significant breed effects were detected for all traits, whereas sex influenced lysozyme and complement component C3 levels. Males generally showed greater lysozyme and complement component C3 levels than females. Higher lysozyme levels were found in Bionda Piemontese (920.8 ng/mL) and Bianca di Saluzzo (766.5 ng/mL), while the highest complement component C3 values were observed in Bionda Piemontese (315.2 µg/mL) and Bianca di Saluzzo roosters (287.4 µg/mL) and in Siciliana hens (329.1 µg/mL). Immunoglobulin Y showed limited variation among breeds and sexes. In turkeys, only lysozyme levels differed between breeds. Overall, these preliminary results, obtained from a limited number of individuals, reveal measurable differences in immune traits among Italian autochthonous poultry breeds, particularly for innate immune parameters, suggesting that genetic background may contribute to variation in immune responsiveness. These findings provide baseline data to support genetic conservation strategies and sustainable breeding programs for resilient poultry systems.

Keywords: autochthonous poultry breeds; innate immunity; immunoglobulin Y; genetic variability; poultry biodiversity



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1. Introduction

Poultry production represents a major component of global animal agriculture and provides an important source of high-quality animal protein for human consumption [1]. In recent decades, increasing attention has been directed towards the conservation and valorization of autochthonous poultry breeds, which represent valuable reservoirs of genetic diversity [2]. In addition, products derived from native poultry breeds are increasingly appreciated for their link to traditional farming systems, local heritage, and perceived quality, thus contributing to maintaining interest in the conservation of autochthonous breeds [3].

The maintenance of genetic variability is a key aspect in conservation programs, as it contributes to animal robustness, defined as the ability of animals or breeds to adapt to environmental challenges such as climate variability, stress conditions, and disease pressure. Robust genotypes are particularly important in alternative poultry production systems, including free-range, organic, and agroforestry farming, where animals are more exposed to environmental stress and pathogens [4].

Disease resistance is influenced by the genetic background of animals and represents an important resource for disease prevention and productivity improvement [5]. Genetic resistance to diseases is a complex polygenic trait largely regulated by the immune system and its interactions with several physiological and environmental factors [6]. Immuno-competence in poultry involves both innate and adaptive immune responses and can be evaluated through several functional parameters, including antimicrobial activity, antibody production, lymphocyte proliferation, and phagocytic activity [5].

Functionally, the immune system is composed of an early-responding innate component and a slower but highly specific adaptive component. Innate immunity constitutes the first line of defense, including physical and chemical barriers at epithelial surfaces such as the skin and the gastrointestinal and respiratory tracts [7]. It also involves humoral and cellular mediators that respond quickly to infection. Among humoral components, antimicrobial molecules such as lysozyme and complement proteins play key roles [7]. Lysozyme is particularly active against Gram-positive bacteria and contributes to parasite control [8]. The complement system consists of a protein cascade that leads to the release of antimicrobial factors and the recruitment of immune cells [7]. Adaptive immunity, on the other hand, provides a more specific and long-lasting response mediated mainly by lymphocytes and antibodies. Immunoglobulin Y (IgY) represents the main serum antibody and plays a crucial role in the humoral immune response [7]. In addition to its protective function in adult animals, IgY is actively transferred from the hen to the egg yolk, providing passive immunity to chicks during the early stages of life [9].

Among the initiatives aimed at safeguarding poultry biodiversity, the national project “Conservation of Biodiversity in Italian Poultry Breeds—TuBAvI” (FEASR/MASAF PSRN 2017–2024) has focused on preserving Italian avian genetic heritage. Since 2017, the TuBAvI project has been dedicated to the conservation, safeguarding, and valorization of Italian poultry breeds. One of the main objectives is to expand knowledge on the phenotypic characteristics of existing breeds to address current knowledge gaps and enhance the economic sustainability of their farming [2,10,11]. Despite the recognized importance of these genetic resources, limited information is currently available regarding their immunological characteristics. The characterization of immune traits in local breeds may provide valuable information for conservation strategies and future breeding programs aimed at improving animal resilience.

Given the gap on the immunological profile of Italian native poultry breeds, the aim of the present study was to provide a preliminary characterization of selected immune traits in these endangered genetic resources. Specifically, we investigated key markers

of innate immunity (lysozyme and complement component C3) and adaptive humoral immunity (IgY) across seven Italian chicken breeds and two turkey breeds and evaluated the influence of breed and sex on these traits to generate baseline data useful for biodiversity conservation and sustainable breeding strategies.

2. Materials and Methods

2.1. Animals

This study involved seven Italian autochthonous chicken breeds, namely Ancona (ANC) and Livorno (LIV), originating from Central Italy; Mugellese (MUG) and Valdarnese Bianca (VLB), from the Tuscany region; Bionda Piemontese (BPM) and Bianca di Saluzzo (BSL), originating from the Piedmont region; and Siciliana (SIC), from the Sicily region. In addition, two Italian autochthonous turkey breeds, namely Romagnolo (ROM) from Emilia-Romagna and Ermellinato di Rovigo (EMR) from the Veneto region, were included in this study. These breeds represent important components of the Italian poultry genetic heritage and originated from local populations historically selected in different geographical areas of Italy according to adaptation to local environmental conditions, productive characteristics, and traditional farming systems. A total of 70 chickens (10 per breed; 5 males and 5 females) and 20 turkeys (10 per breed; 5 males and 5 females) were sampled. The animals used in this study were between 8 and 11 months of age. Birds were reared according to standard management guidelines for chicken and turkey breeders. All animals had ad libitum access to drinking water and were fed a standard commercial breeder diet formulated to meet species-specific nutritional requirements: chickens received a diet containing 15% crude protein (CP) and 2800 kcal ME/kg, while turkeys were fed a diet containing 16% CP and 2800 kcal ME/kg. All birds received the same diet throughout the experimental period. The relatively small sample size reflected the limited availability of reproductively active adult animals within the TuBAvI conservation program. The investigated breeds are endangered Italian autochthonous genetic resources maintained in conservation nuclei, where population sizes are inherently restricted.

Although the conservation nuclei are located in different geographical areas of Italy, all birds were managed within the TuBAvI conservation program according to standardized breeding recommendations, including comparable husbandry practices and species-specific nutritional management. Nevertheless, minor environmental differences among conservation farms, such as local climatic conditions and microbial exposure, cannot be completely excluded.

2.2. Sample Collection

Blood samples were collected by venipuncture from the wing vein in chickens and the brachial vein in turkeys during routine health monitoring, with an additional small volume (approximately 1 mL) obtained for immunological assays. After clotting for 2 h at room temperature, serum was separated by centrifugation at 3000 rpm for 15 min and stored at -20°C until analysis. All samples were analyzed within 4–5 weeks after collection. The serum concentration of lysozyme and complement component C3 and IgY concentrations were quantified using avian-specific commercial ELISA kits (MyBioSource, San Diego, CA, USA). All assays were performed in duplicate according to the manufacturer's instructions.

2.3. Assessment of Immune Parameters

Serum lysozyme concentration was determined using a competitive ELISA kit, according to the manufacturer's instructions. Briefly, 50 μL of seven different standard solutions and 50 μL of undiluted serum samples were dispensed into duplicate wells of the microplate. Subsequently, 50 μL of horseradish peroxidase-conjugated antibody (HRP

conjugate, 1×) was added to each well. The plate was gently mixed and incubated at 37 °C for 1 h to allow the competitive immunoreaction to occur. After incubation, the solution was aspirated, and the plate was washed with 250 µL of wash buffer (1×) per well to remove unbound components. Then, 100 µL of substrate solution was added to each well, and the plate was incubated at 37 °C for 15–20 min in the dark to allow for color development. The reaction was stopped by adding 50 µL of stop solution to each well, resulting in a color change from blue to yellow. Optical density was measured at 450 nm within 5 min using a microplate reader (Tecan Infinite® M Nano, Tecan Trading AG, Männedorf, Switzerland). Lysozyme concentrations in serum samples were expressed in ng/mL and calculated by interpolation from the logarithmic standard curve generated using the absorbance values of the standards.

Serum complement component C3 concentrations were quantified using a sandwich ELISA kit. Briefly, 50 µL of six standard concentrations and 50 µL of sample were added to the wells. Subsequently, 100 µL of HRP-conjugated reagent was added, and the plate was incubated at 37 °C for 60 min. Following incubation, the contents of the wells were aspirated, and the plate was washed four times manually with 1× wash solution. Then, 50 µL of chromogen solution A and 50 µL of chromogen solution B were added in the dark. After gentle mixing, the plate was incubated at 37 °C for 15 min and protected from light. Finally, 50 µL of stop solution was added, and absorbance was measured at 450 nm within 15 min. Complement component C3 concentration was expressed as µg/mL and was calculated from the linear standard curve generated using the absorbance values of the standards against their known concentrations.

IgY concentration was determined using an ELISA kit according to the manufacturer's instructions. Serum samples were diluted 1:50,000 (*v:v*) with diluent 1× provided in the kit. A total of 100 µL of standard solutions (*n* = 7) and 100 µL of diluted serum samples were dispensed in duplicate into the wells of the microplate. The plate was covered and incubated for 30 min at room temperature. After incubation, the plate was washed with wash solution (1×) to remove unbound components. Subsequently, 100 µL of enzyme-antibody conjugate (anti-IgY antibodies conjugated with horseradish peroxidase) was added to each well. Following an additional washing step, 100 µL of TMB substrate solution (3,3',5,5'-tetramethylbenzidine) was added to allow for color development. After incubation at room temperature for 10 min, the reaction was stopped by adding 100 µL of stop solution. All steps were performed using a multichannel pipette (Discovery DV8-200, HTL Lab Solutions, Warsaw, Poland). Absorbance was measured as described for the other immune markers using a Tecan Infinite® M Nano microplate reader. The IgY concentrations were expressed in mg/mL and were calculated from the second-order polynomial standard curve obtained by interpolating the absorbance values of the standards and correcting for the initial dilution factor.

2.4. Statistical Analysis

Preliminary analysis using the Shapiro–Wilk test indicated that all immune markers were normally distributed. Data for lysozyme, complement component C3, and IgY were analyzed separately for each species (chicken and turkey) using a two-way factorial general linear model (GLM), including the fixed main effects of breed, sex, and their interaction. A multiple comparison of means was performed for the interaction effect using Duncan's multiple range post hoc test. Statistical analyses were performed using SPSS software (version 23.0 for Windows; SPSS Inc., Chicago, IL, USA). The results are expressed as least squares means (LSMs) ± SE, and significance was set at *p* < 0.05.

3. Results

3.1. Immune Parameters in Chickens

According to the GLM used to evaluate the effects of breed, sex, and their interaction on immune markers, chicken breed had a significant effect on all variables analyzed (Table 1). The effect of sex was significant for lysozyme and complement component C3 and approached significance for IgY ($p = 0.051$). The interaction between breed and sex was significant only for complement component C3 and approached significance for lysozyme ($p = 0.066$) and IgY ($p = 0.061$; Table 1).

Table 1. Least squares means $\pm$ SE of immune markers for breed $\times$ sex interaction in seven Italian autochthonous chicken breeds.

Breed	Sex	Immune Markers		
		Lysozyme (ng/mL)	Complement C3 (μ g/mL)	IgY (mg/mL)
Siciliana	M	331.5 $\pm$ 70.3 ^{e-g}	272.1 $\pm$ 30.3 ^{ab}	14.3 $\pm$ 1.6 ^{a-d}
	F	264.9 $\pm$ 145.5 ^{f-h}	329.1 $\pm$ 46.0 ^a	19.0 $\pm$ 0.7 ^a
Ancona	M	625.0 $\pm$ 36.4 ^{b-e}	113.3 $\pm$ 31.5 ^{c-e}	14.5 $\pm$ 1.9 ^{a-d}
	F	256.4 $\pm$ 28.7 ^{f-h}	60.5 $\pm$ 5.2 ^e	15.9 $\pm$ 1.9 ^{abc}
Livorno	M	805.5 $\pm$ 185.5 ^{ab}	94.0 $\pm$ 3.2 ^{de}	9.8 $\pm$ 1.6 ^{de}
	F	143.0 $\pm$ 26.3 ^{gh}	46.0 $\pm$ 18.1 ^e	17.4 $\pm$ 1.9 ^{ab}
Mugellese	M	506.4 $\pm$ 88.2 ^{c-e}	192.4 $\pm$ 31.1 ^{bc}	13.1 $\pm$ 2.2 ^{b-d}
	F	130.7 $\pm$ 4.6 ^h	188.3 $\pm$ 38.3 ^{bc}	9.4 $\pm$ 1.0 ^{de}
Valdarnese Bianca	M	426.5 $\pm$ 69.1 ^{d-f}	157.0 $\pm$ 47.2 ^{cd}	11.1 $\pm$ 1.9 ^{c-e}
	F	134.6 $\pm$ 69.4 ^{gh}	113.8 $\pm$ 8.5 ^{c-e}	10.8 $\pm$ 1.3 ^{c-e}
Bianca di Saluzzo	M	766.5 $\pm$ 86.0 ^{ab}	287.4 $\pm$ 21.3 ^a	7.3 $\pm$ 1.3 ^e
	F	513.8 $\pm$ 77.2 ^{c-e}	170.1 $\pm$ 13.5 ^{cd}	9.2 $\pm$ 1.8 ^{de}
Bionda Piemontese	M	920.8 $\pm$ 55.2 ^a	315.2 $\pm$ 42.3 ^a	9.1 $\pm$ 1.9 ^{de}
	F	653.2 $\pm$ 118.2 ^{b-d}	189.8 $\pm$ 20.6 ^{bc}	10.4 $\pm$ 1.9 ^{c-e}
Breed effect		$p < 0.001$	$p < 0.001$	$p < 0.001$
Sex effect		$p < 0.001$	$p = 0.004$	$p = 0.051$
Breed $\times$ sex effect		$p = 0.066$	$p = 0.046$	$p = 0.061$

^{a-h} Different superscript letters within immune markers indicate significant differences between the levels of the breed $\times$ sex interaction.

The LSMs of lysozyme, complement component C3, and IgY concentrations for the breed $\times$ sex interaction in seven autochthonous chicken breeds are presented in Table 1. The highest lysozyme concentrations (ng/mL) were observed in BPM males, which showed significantly higher values than BPM females and the males of all other breeds, except for BSL and LIV males. In all breeds, lysozyme levels were higher in males than in females ($p < 0.05$), except in SIC, where similar values were observed between sexes. BPM females exhibited higher lysozyme concentrations than the females of all other breeds, except for BSL. The lowest lysozyme values were observed in SIC males and MUG females. For complement component C3 (μ g/mL), the highest values were observed in SIC, as well as in BPM and BSL males ($p < 0.05$). Similarly to lysozyme, males showed higher complement levels than females in all breeds except SIC, with significant differences particularly in BSL and BPM. The lowest complement concentrations were detected in ANC and LIV. For IgY (mg/mL), the highest values were observed in SIC females, which were higher than those in both sexes of MUG, VLB, BSL, and BPM, as well as in LIV males ($p < 0.05$). No significant

sex-related differences were detected within most breeds, except for LIV, where females exhibited higher IgY concentrations than males ($p < 0.05$).

3.2. Immune Parameters in Turkeys

Table 2 shows the LSMs of immune markers in the turkey breeds. Following GLM analysis, a significant effect of both breed and sex was observed only for lysozyme concentrations, the sex effect approached significance for complement component C3 ($p = 0.053$) and no significant interaction between breed and sex was recorded for all traits considered. Specifically, EMR males showed significantly higher lysozyme levels (ng/mL) than ROM males and the females of both breeds ($p < 0.05$). For complement concentrations ($\mu\text{g/mL}$), no significant differences were detected between breeds ($p = 0.737$). However, in both breeds, males showed higher complement values than females, although the differences were not statistically significant. Finally, IgY concentrations (mg/mL) did not differ between breeds ($p = 0.156$) or sexes ($p = 0.920$).

Table 2. Least squares means $\pm$ SE of immune markers for breed $\times$ sex interaction in two Italian autochthonous turkey breeds.

Breed	Sex	Immune Markers		
		Lysozyme (ng/mL)	Complement C3 ($\mu\text{g/mL}$)	IgY (mg/mL)
Romagnolo	M	408.2 $\pm$ 46.9 ^b	430.2 $\pm$ 82.3 ^a	4.4 $\pm$ 1.2 ^a
	F	188.4 $\pm$ 19.6 ^c	295.3 $\pm$ 40.2 ^a	4.1 $\pm$ 1.7 ^a
Ermellino di Rovigo	M	694.4 $\pm$ 82.1 ^a	400.9 $\pm$ 29.4 ^a	2.4 $\pm$ 0.5 ^a
	F	391.2 $\pm$ 76.8 ^b	269.3 $\pm$ 62.7 ^a	2.8 $\pm$ 0.4 ^a
Breed effect		$p = 0.003$	$p = 0.737$	$p = 0.156$
Sex effect		$p = 0.002$	$p = 0.053$	$p = 0.920$
Breed $\times$ sex effect		$p = 0.912$	$p = 0.893$	$p = 0.751$

^{a–c} Different superscript letters within immune markers indicate significant differences between the levels of the breed $\times$ sex interaction.

4. Discussion

The present study provides preliminary insights into the variability in selected immune markers among Italian autochthonous poultry breeds, revealing breed-related differences and, to a lesser extent, sex-related differences. The variability observed in lysozyme, complement component C3, and IgY concentrations suggests that local breeds may exhibit distinct immunological profiles that contribute to their adaptive capacity and resilience under different environmental and management conditions. The immune traits evaluated in this study may be affected by both genetic and environmental factors. Although all birds were managed following the same guidelines within the TuBAvI conservation program, the conservation nuclei are located in different areas of Italy. Therefore, differences in climate, farm management, and microbial exposure may have influenced the observed immune responses. This study was not designed to separate genetic and environmental effects; therefore, the observed breed differences may reflect the combined influence of genetic background, environmental conditions, and other factors.

This variability may partly reflect the evolutionary history of autochthonous breeds, which developed under local environmental pressures and relatively low selection intensity for production traits, thereby preserving genetic diversity related to immune function and robustness [6,12]. In this context, the differences detected among breeds suggest that genetic background may contribute to variation in immune responses in poultry, although the potential influence of environmental factors should also be considered. Avian populations

exhibit considerable genetic and physiological variability influencing immunocompetence and resistance to infectious diseases [5,13–15].

Consistent with our findings, Freier et al. [15] reported breed-specific immune profiles in local chicken breeds, including differences in T-cell populations and humoral responses. These results support the hypothesis that immunological variability among local genotypes may influence their adaptability and health status. Similarly, Kannaki et al. [16] demonstrated variable resistance among Indian native chicken breeds following experimental infection with *Pasteurella multocida*, confirming that disease susceptibility can differ substantially among genetic groups. Native genotypes have often been associated with enhanced immune competence, including higher complement activity, increased lysozyme levels, and stronger antibody responses compared with highly selected commercial lines. In agreement with these findings, lysozyme concentrations in our study varied markedly among breeds, with the highest levels observed in specific chicken breeds (e.g., BPM and BSL) and in the ERM turkey breed. Lysozyme is a key antimicrobial enzyme involved in innate immunity, primarily acting by hydrolyzing the peptidoglycan layer of bacterial cell walls, particularly in Gram-positive bacteria [17,18]. Beyond its bacteriolytic activity, lysozyme also contributes to immune regulation and inflammatory responses and is commonly used as an indicator of nonspecific immune defense in birds [19,20]. Variability in lysozyme activity among breeds has been previously reported and may reflect differences in innate immune responsiveness associated with genetic background and environmental adaptation [8]. The relatively high lysozyme concentrations observed in some breeds may represent an adaptive trait associated with long-term exposure to heterogeneous environmental conditions and pathogen pressure. Birds reared in traditional or extensive production systems are generally exposed to a greater diversity of microorganisms than those raised under intensive conditions, which may contribute to differences in baseline innate immune responsiveness [21,22].

Sex-related differences were also observed for lysozyme concentrations, with males generally exhibiting higher values than females in most breeds. Sex-related differences in immune traits have been reported in birds and may result from the complex interaction among endocrine regulation, reproductive status, genetic background, and environmental factors [23]. Although sex steroids are recognized as important modulators of immune function in vertebrates, their specific contribution to sexual dimorphism in avian immune responses remains poorly understood [24]. Therefore, the higher lysozyme concentrations observed in males in the present study may reflect the combined influence of multiple physiological and environmental factors rather than a direct effect of sex hormones alone. However, the mechanisms underlying these sex-dependent differences remain unclear, and further studies are needed to elucidate the physiological and genetic factors involved.

Complement component C3 concentrations showed significant variability among chicken breeds, whereas no significant breed-related differences were detected in turkeys. Relatively high complement concentrations were observed in the SIC, BPM, and BSL breeds, which may indicate a more active basal innate immune defense in these populations. The complement system represents a crucial component of innate immunity and plays a central role in pathogen recognition, opsonization, and lysis. The activation of complement proteins leads to the formation of membrane attack complexes and the generation of inflammatory mediators that recruit immune cells to sites of infection [25]. In avian species, complement proteins are involved in early host defense and contribute to the rapid elimination of pathogens before the activation of adaptive immune responses [26,27]. Breed-related variability in complement activity has been previously documented in poultry populations. For example, differences in complement activity among turkey breeds were

reported by Franciosini et al. [28], suggesting that genetic factors may significantly influence innate immune mechanisms.

Similarly to lysozyme, complement component C3 concentrations tended to be higher in males than in females in some chicken breeds, although statistically significant differences were observed only in BPM and BSL. Sex-related differences in complement levels may result from interactions among reproduction, metabolism, and immune function, influenced by hormones, genetic background, and environmental factors, making it difficult to attribute these differences to a single cause [29].

Unlike the innate immune markers considered, IgY concentrations showed more limited variability among breeds, suggesting a lower influence of sex. The relatively high IgY concentrations observed in SIC and ANC may reflect an enhanced humoral immune capacity in these populations. IgY is the predominant circulating immunoglobulin in birds, functionally comparable to mammalian IgG, and represents a central component of humoral adaptive immunity [30]. Several studies have quantified IgY levels in chicken serum using ELISA-based approaches, confirming the relevance of this trait as an indicator of immune status and physiological condition [31,32]. Although IgY is primarily associated with adaptive immunity, its physiological importance is also linked to maternal antibody transfer, as circulating IgY is actively transported from serum to egg yolk, providing passive immune protection to chicks during early life stages [31]. A positive correlation between serum IgY levels and egg yolk IgY concentrations has been demonstrated in different chicken breeds, supporting the role of IgY in maternal immunity and in protecting chicks from infections during the first weeks after hatching [31]. In the present study, the relatively high IgY concentrations observed in SIC and ANC may suggest a greater capacity to confer passive immunity to chicks during early life, although further studies are needed to confirm this hypothesis. Experimental evidence has shown substantial individual variability in IgY levels following antigen exposure, indicating that humoral responses may be influenced by both genetic and environmental factors [33].

Interestingly, sex-related differences in IgY concentrations were limited in most breeds, suggesting that humoral immunity may be less influenced by sex than innate immune traits. In agreement with our findings, Valdebenito et al. [29], in a meta-analysis of wild birds, reported that overall immune status is not consistently biased toward either sex across different immune measures. However, sex-related differences may emerge depending on physiological state and context (e.g., breeding versus non-breeding season), indicating that sexual dimorphism in immune function is complex and parameter-specific rather than uniform.

Although breed-related differences were observed in the immune markers evaluated, these findings should not be interpreted as direct evidence of differences in disease resistance. The serum concentrations of lysozyme, complement component C3, and IgY provide useful information on immune status and immunological variability among breeds; however, they do not directly predict the ability of animals to resist specific pathogens.

Overall, these preliminary data indicate the existence of measurable variation in immune traits among Italian autochthonous chicken breeds, which deserves further investigation. The observed differences may reflect the diverse environmental and management conditions under which these populations have historically evolved. Local breeds have generally been maintained in low-input farming systems, often characterized by variable climatic conditions and continuous exposure to diverse microbial challenges. These factors may have contributed to the preservation of genetic diversity associated with immune function and adaptive capacity. The maintenance of such variability is increasingly recognized as a key element for supporting livestock resilience and preserving functional traits related to disease resistance and environmental adaptation [34].

A limitation of the present study is that only the serum concentrations of immune molecules were evaluated, without assessing their functional activity. Although ELISA-based quantification provides valuable information on immune status and allows for comparisons among genetic groups, protein abundance does not necessarily correspond to biological activity. Future studies integrating functional assays, such as lysozyme activity and complement activation tests, together with molecular approaches, will be necessary to better characterize the immune capacity of Italian autochthonous poultry breeds.

5. Conclusions

In conclusion, the present study provides the first characterization of selected innate and adaptive immune markers in Italian autochthonous poultry breeds. Significant variability was observed primarily in lysozyme and complement component C3 concentrations, suggesting an association with genetic background on innate immune responses, whereas IgY levels showed more limited variation among breeds and between sexes.

The interpretation of these results should consider the limited sample size, which was mainly determined by the conservation status and restricted population availability of the investigated breeds. Furthermore, although the observed breed differences suggest that genetic background may contribute to variation in immune responsiveness, the potential influence of environmental factors cannot be excluded. Therefore, the reported values should be considered baseline reference data for endangered Italian poultry genetic resources. Nevertheless, these findings provide useful information for future comparative studies and contribute to the development of monitoring strategies for the conservation and sustainable management of local poultry populations.

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