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Complement activity in Bulgarian local sheep related to season and breed


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Abstract. The studies were performed in 2008 on 308 sheep at the age of 2-4 years. Sheep from the following breeds were used: Karakachan, Tsigay, Replyan, Panagyurishte, Copper-red Shoumen, Karnobat, Pleven Blackhead, White Maritsa, Patch-faced Maritsa, Stara Zagora and Romanov. During the spring and summer, 6 sheep from each breed were used and during the summer – 20. The activity of the alternative pathway of complement activation was assayed by the method of Sotirov (1991). During the spring, the highest blood complement concentrations were determined in Panagyurishte (215.24 ± 5.22), White Maritsa (206.87 ± 13.12) and Copper-red Shoumen breeds (201.15 ± 8.88), and the lowest in Romanov (160.23 ± 7.44) and Pleven Blackhead breed – 164.09 ± 12.86 (р < 0.01). The highest summer complement levels were measured in Panagyurishte breed (218.80 ± 3.285 СН50), and the lowest - in Tsigay breed (167.144 ± 5.233 СН50) (р < 0.01). During the autumn, Karakachan breed were with the highest complement concentrations (205.79 ± 13.28), whereas Pleven Blackhead – with the lowest – 169.04 ± 10.10 (р < 0.01). Totally for all sheep studied, the average APCA concentrations were 190.87 ± 5.87 during the spring, 190.028 ± 8.284 СН50 during the summer and 191.24 ± 8.47 during the winter.

Keywords: complement, season, breeds, sheep.

Introduction

The activity of phagocytosis, complement, beta-lysins, interferon and immunoglobulins determine the quality of both natural and specific immune response (Arsov et al., 1979; Ado and Myanek, 1983; Kolivanova, 1987; Buschmann and Kleinschmidt, 1988; Kishko and Ganova, 1989; Zyczko and Zyczko, 1998; Uzonna et al., 1999). They could be used as biological tests for evaluation of systemic immune status.

The system of complement is an essential part of the mechanisms of resistance. It is a multicomponent biochemical system consisting of plasma proteins that interact between each other in a cascade, providing a rapid and aggressive response. These proteins are covalently bound to the surface of microorganisms and destroy them. The complement system could be activated by either the carbohydrate microbial structures in the absence of antibodies or by antibodies, attached to microbial cells. Thus, it plays the role of a bridge between the innate and adaptive immune responses (Andonova and Gundasheva, 2007). The complement executes a variety of defense functions, resulting in destruction (lysis) of erythrocytes, bacterial cells, viruses, virus-infected cells, neoplastic cells etc. (Lie, 1985; Tanchev, 2006). It is also able to induce important biological reactions as agglutination, precipitation, phagocytosis and binding of C component, i.e. it has functional characteristics similar to those of immunoglobulins (Muller, 1983; Emelyanko, 1985; Kulberg, 1985).

The normal activities of complement related to the species, breed, age, season and the physiological state are reported for cattle (Emelyanenko, 1977; Bodjagin and Loushnikov, 1979; Sotirov et al., 2007), swine (Canfield, 1963; Canfield and Liu, 1965; Campbell et al., 1970; Burger et al., 1983; Sotirov, 1991; Sotirov et al., 1993; Tanchev, 2006), rabbits (Chernov and Boychew, 1992; Tanchev, 2006), sheep (Bivolarski and Sotirov, 2001; Sotirov et al., 2005; Sotirov, 2006), goats (Semerdjiev et al., 2008), and poultry (Semerdjiev, 1989; Sotirov et al., 1989).

Because of the scarce information in available literature, the aim of this investigation was to study the seasonal and breed-related particularities of blood complement in local sheep breeds reared in different regions in Bulgaria.

Material and methods

The studies were performed in 2008 on 308 sheep at the age of 2-4 years. Sheep from the following breeds were used: Karakachan, Tsigay, Replyan, Panagyurishte, Copper-red Shoumen, Karnobat, Pleven Blackhead, White Maritsa, Patch-faced Maritsa, Stara Zagora and Romanov. During the spring and summer, 6 sheep from each breed were used and during the summer – 20. The animals were owned by the Institute of Mountain Animal Stockbreeding and Agriculture, Troyan, the Agricultural Institutes in Karnobat and Shoumen, the Experimental Farm of the Trakia University Stara Zagora and private farmers from Chiparan, Saedinenie, Vidin and Panagyurishte. Blood for analysis was aseptically obtained from v. jugularis with individual needles after proper fixation of animals. The activity of the alternative pathway of complement activation (APCA) was assayed by the method of Sotirov (1991). Data were processed by one-way analysis of variance (ANOVA) with fixed effects of the factor. The effects of breed and age upon the resulting trait (APCA activity) were studied in sheep. The linear model of analysis was as follows:

\[ y_{ij} = \mu + \alpha_i + \epsilon_{ij} \]

where

\[ y_{ij} \] – values of the trait for the different variants;
\[ \mu \] – values of the trait for the different variants;
\[ \alpha_i \] – differential effects of the factor age or breed upon the
analyzed trait; 
\( \varepsilon_{ij} \) – random error.

**Results**

Seasonal blood APCA values in the different sheep breeds are presented in Figure 1. During the spring, the highest blood complement concentrations were measured in Panagyurishte breed (215.24 ± 5.22), White Maritsa (208.87 ± 13.12) and Copper-red Shoumen breed (201.15 ± 8.88), and the lowest – in Romanov (160.23 ± 7.44) and Pleven Blackhead breed (164.09 ± 12.86) \((p < 0.01)\). Similar APCA values were obtained for Karnobat breed (190.76 ± 7.50), Tsigay (187.79 ± 11.65), Patch-faced Maritsa 

(183.41 ± 8.20), Stara Zagora breed (181.75 ± 4.50) and Replyan sheep breeds (180.06 ± 13.71 CH50) (CH50 units correspond to 50% of complement-induced haemolysis of applied erythrocytes).  

Phenotype variety in complement levels was also observed during the summer. The highest complement concentrations were exhibited by Panagyurishte sheep (218,801 ± 3,285 CH50), whereas the lowest – by Tsigay sheep (167,144 ± 5,233 CH50) \((p < 0.01)\). The values for the other studied breeds were between these values: for White Maritsa – 203,928 ± 8,284 CH50; Patch-faced Maritsa – 192,961 ± 4,934 CH50; Stara Zagora – 181,734 ± 5,681 CH50; Copper-red Shoumen – 192,364 ± 3,313 CH50; Pleven Blackhead – 191,734 ± 5,681 CH50; Replyan – 181,751 ± 7,080 CH50; Karnobat – 181,398 ± 5,085 CH50; Karakachan – 177,435 ± 4,082 CH50.

The highest autumn complement was observed in Karakachan sheep, values increased throughout the year, in Tsigay they decreased during the summer and increased in autumn. Replyan and Panagyurishte breeds marked a summer increase in complement, Copper-red Shoumen showed the highest concentrations in spring, Pleven Blackhead sheep exhibited an increase in summer and then reduction in autumn, White Maritsa showed a decrease in summer vs increase in Patch-faced Maritsa. Blood complement in Stara Zagora sheep increased gradually over the seasons whereas in Romanov breed – during the autumn.

![Figure 1. Seasonal and breed-related particularities of blood complement activity (CH50) in local sheep breeds](image_url)
Discussion

The differences in blood complement of sheep from different breeds are possibly a consequence of immune system adaptation to environmental conditions in the dwelling areas and the local antigens. Being descendants to old Karakachan and Tsigay sheep, contemporary sheep carry at a various extent hereditary information of their progenitors that could be partly responsible for the different complement activity, but is probably also related to their production type as well as to environmental factors such as ambient temperature, humidity, altitude, pasture sward, soil type, air and water status, etc.

As seen from the results, the breed as an independent factor has a high statistically significant effect upon APCA blood activity. It therefore implies the existence of considerable variations in this element of non-specific immunity in sheep breeds tested. A possible reason is the different genetic potential of sheep breeds with regard to this trait. In previous studies of ours (Sotirov et al., 2006), breed-related differences in complement activity were shown in rams as well. On the average, APCA values in rams were 169.085 ± 2.883 CH50, with a trend towards lowest activity in Karakachan rams (159.258 ± 3.883 CH50), and higher concentrations in Suffolk (163.104 ± 14.837 CH50); Tsigay – 165.260 ± 3.919 CH50; Staroplainska (179.067 ± 9.814 CH50); Chico (182.257 ± 0.50 CH50); Ille de France (183.958 ± 5.241 CH50); Romanov (187.225 ± 7.653 CH50) and Mouton Charolais (203.949 ± 5.544 CH50) breeds. In sheep, Bivolarski and Sotirov (2001) observed increased winter lysozyme activity and higher summer complement concentrations. Therefore, the season had an effect on these parameters. Various blood APCA activities were reported by other authors for different sheep breeds (Audran et al., 1962, Sotirov, 2006), as well as for horses (Sotirov, 2006) and swine (Sotirov, 1991).

In previous research with goats, we concluded that winter complement concentrations were higher in studied Bulgarian breeds and age groups from both genders, compared to respective summer levels. Blood APCA and lysozyme in goats depended on age, breed and gender (Semerdjiev et al., 2006; 2008).

Breed-related differences in complement activities were found in cattle (Sotirov et al., 2007). Wambura et al. (1998) have compared the resistance against ticks of three Zebu breeds (Meru, Mbullu, Iringa Red) and their crosses with Friesian cattle and found out that purebred Zebu were more resistant to parasites than crosses. Purebred Zebu had higher blood complement activity than crossbreds. It was thus assumed that the higher level of complement activity was important for the higher resistance of the three investigated Zebu breeds. This assumption was supported by the statistically significant correlation between parasitaemia rate and the peripheral lymphocyte subpopulations in swine. Zentralblatt f"ur Veterinarmedizin Series B., 35 (3), 230-236.

Breed-related differences in complement activities were reported in cattle by Grizlova et al. (1978). Serum APCA in adult cattle ranged between 25 and 429 CH50, whereas in calves – between 24 and 256 CH50. Similar data were communicated by Renshaw and Everson (1979). Eckblad et al. (1981) observed serum APCA concentrations of 11.6 CH50 in adult cows, in calves – 51.6 CH50, and in colostrum serum – 5.0 CH50.

Breed-related variations in complement activity were reported by Sotirov (2008) in horse as well, whereas in sheep blood lysozyme and complement were also influenced by the temperament and production type of animals.

The research in this field contributes to the detailed elucidation of the effect of complement and other factors of immunity on livestock productivity and resistance as well as on genetic control and phenotype manifestation under the influence of various environmental factors.

Conclusion

During the spring, the highest blood complement concentrations were determined in Panagyurishte, White Manitsa and Copper-red Shoumen breeds, and the lowest – in Romanov and Pleven Blackhead breeds. The highest summer complement levels were measured in Panagyurishte breed and the lowest – in Tsigay breed. During the autumn, Karakachan sheep were with the highest complement concentrations, whereas Pleven Blackhead – with the lowest. Totally for all sheep studied, the average APCA concentrations were 190.87 ± 5.87 during the spring, 190.03 ± 8.28 CH50 during the summer and 191.24 ± 8.47 during the winter.

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