The lymphocytes are responsible for immune response whereas, monocytes are the second line of cellular defense and are at times also referred as scavenger cells. The ultrastructural studies of blood cells of camel (Singh et al., 1997), buffalo calves (Singh, 2000) and pig (Mehta et al., 2013) have been documented. References on blood cells of horse are meager. Hence the present study was conducted to explore its application in various fields of veterinary sciences.

MATERIALS AND METHODS

The study was conducted on 6 apparently healthy horses maintained at Horse Unit of College of Veterinary Sciences and Animal Husbandry, Kanke, Ranchi as well as nearby villages. Five ml of blood was taken from the jugular vein in a sterilized and siliconized tube containing EDTA as anticoagulant and centrifuged at 3000 rpm for 30 minutes. The excess of plasma was drained off. The buffy coat was fixed with 2-3 ml of modified Karnovsky's fluid. It was taken out of the tube with the help of hooked wire and cut into thin and small slices of approximately 1 mm thickness. The samples washed in phosphate buffer at pH 7.2 were dehydrated in graded acetone solutions and embedded in beam capsule. Ultrathin sections of 60-80 nm thickness were cut and stained with alcoholic uranyl acetate and lead citrate. These sections were then placed on grids and examined under JEOL electron microscope at College of Veterinary Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar.

RESULTS AND DISCUSSION

The lymphocytes were rounded in shape with cytoplasmic processes. The heterochromatin of nucleus was comparatively less than the euchromatin. The small lymphocytes had centrally placed nuclei with huge amount of heterochromatin. The spherical monocyte had heterochromatin and euchromatin distributed in patches. The cytoplasm showed few large and small sized electron dense granules. The neutrophils were roughly round in shape. Population of electron dense granules was comparatively greater than electron- lucent. Eosinophils appeared round to oval in shape with long and narrow cytoplasmic processes. Granules were mostly oval almost of similar in shape and size. The basophils were roughly spherical in outline with few and short cytoplasmic processes. The cytoplasmic granules were extremely large than those of neutrophils and eosinophils and varied from 1.2 µ to 1.9 µ in size.

**Key words:** Basophil, Eosinophil, Lymphocyte, Monocyte, Neutrophil, TEM

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that the lymphocytes had very small dense granules spread all over in the cytoplasm. Large number of mitochondria were usually aggregated adjacent to the nuclear indentation. Menaka and Singh (2003) reported that the cytoplasm of goat lymphocytes had large sized mitochondria with well developed septae. The medium sized lymphocytes had comparatively larger amount of cytoplasm. The numerous mitochondria were of different sized, empty vesicles; phagocytic vesicles and rough endoplasmic reticulum were observed. The large sized lymphocytes were having comparatively thick and short cytoplasmic processes. The nucleus of small lymphocyte was very small and centrally placed. The nucleus had distinct nuclear membrane with distinct numerous nuclear pores at different places. Heterochromatin was more than euchromatin and was located at periphery of the nucleus (Fig. 2). In large and medium sized lymphocytes, the nuclei were spherical in outline with some puffiness and indentation. Euchromatin was more than heterochromatin. Heterochromatin was mostly located at the periphery but few patches were also seen in central region (Fig. 1). Mehta et al. (2013) noticed that nuclei of small and medium lymphocytes were placed centrally with distinct nuclear membrane in pig. The heterochromatin was comparatively less when compared to euchromatin and distributed peripherally in the form of patches. Numerous nuclear pores in small lymphocytes and larger sized nuclear pore in medium lymphocytes were observed.

The monocytes were almost spherical in outline. The cytoplasmic processes were few and comparatively smaller in size. The nucleus was eccentrically placed, varied in shape and deeply curved. The heterochromatin distributed in patches. The cytoplasm showed very few large and small sized electron dense bodies and round mitochondria. Pinocytic vesicles and vacuoles were also observed (Fig. 3). Whereas, Hammer and Weber (1974) noticed pleomorphic granules in cow. Singh et al. (1997) reported that camel agranulocytes had large number of mitochondria and vesicles. Some of these cells had electron lucent granules. Cytoplasmic processes were comparatively long which varied in shape, size and number. Nucleus were deeply indented and varied in shape. The heterochromatin was confined towards periphery except the nuclear pore area (Mehta et al., 2013).

**Neutrophils:** The neutrophils were roughly rounded in shape. The nucleus was 2-4 lobed and surrounded by distinct nuclear membrane (Fig. 1) as reported in goats (Menaka and Singh, 2004). The euchromatin was comparatively less and centrally located whereas the heterochromatin occupied major peripheral portion of the nuclear lobes. Singh et al. (1997) stated that the camel neutrophils had 3-4 nuclear lobes with distinct outer densely packed chromatin underneath the nuclear membrane and central portion was occupied by the loosely arranged chromatin. Mehta et al. (2012) stated that the nucleus was 2-5 lobed and the heterochromatin occupied major peripheral portion of the nuclear lobes whereas the euchromatin was comparatively less and centrally located in the form of patches in pig. The granules were mostly elongated in shape however, rounded to oval granules were also seen. Population of electron dense granules was comparatively greater than electron lucent. Only some granules had central electron dense spot surrounded by electron lucent area whereas granules with central electron lucent area with peripheral electron dense area were very scanty (Fig. 4). The phagocytic vacuoles were scattered throughout the cytoplasm. Sonoda and Kobayashi (1970) reported that the canine neutrophils had three types of granules. The vesicular bodies were found in cytoplasm of some neutrophils. Mehta et al. (2012) observed that the granules of pig neutrophils were mostly rounded, oval and elongated in shape. Population of electron lucent granules was comparatively greater than electron dense. The round shaped electron lucent granules were of two types. The phagocytic vacuoles were found towards the periphery.

**Eosinophils:** Eosinophils appeared round to oval in shape with long and narrow cytoplasmic processes (Fig. 5). The nucleus had two to three lobes with distinct nuclear membrane. The nuclear lobes had almost equal quantity of euchromatin and heterochromatin (Fig. 5). The heterochromatin was concentrated towards the periphery except nuclear pores. The nuclear pores were distinct. Singh et al. (1997) noticed that the eosinophils in camel had the nucleus with densely packed chromatin at the periphery as compared to central part. Mehta et al. (2012) described that the nucleus of eosinophils in pig had two to three lobes with distinct nuclear membrane and nuclear lobes were having less amount of heterochromatin as compared to
neutrophils. Granules were mostly oval in outline and more or less similar in shape and size. Electron dense material was placed eccentrically in most of the granules (Fig. 2). Vacuoles were scattered in granular zone of the cytoplasm. The cytoplasmic organelles like mitochondria, Golgi apparatus were also seen (Fig. 2). Menaka and Singh (2004) observed that cytoplasm of goat eosinophil contained mainly round oval and elongated membrane bound granules of different sizes. The secondary granules (specific granules) of canine eosinophil varied from dense homogenous granules surrounded by anarrow rim of lighter matrix to a clear vesicle with only a cap of dense material. Mehta et al. (2012) reported that the cytoplasmic granules in pig eosinophil were roughly rounded to oval and were of four types with various pattern of distribution of electron dense and electron lucent materials.

Basophils: The basophils were roughly spherical in outline with few and short cytoplasmic processes (Fig. 6). The nucleus was eccentrically placed and was having 1-2 lobes. The heterochromatin was distributed towards the periphery whereas loosely arranged euchromatin at the centre. Singh et al. (1997) in camel observed that the nucleus had a densely packed chromatin material more at the periphery and occupied more space as compared to centrally placed loose chromatin. Singh (2000) noticed that in the buffalo calves basophils were seen as circular shaped with few cytoplasmic processes. The nucleus was usually bilobed with condensed chromatin arranged at periphery and loosely arranged chromatin in the center. Mehta et al. (2012) described that the pig basophils were roughly spherical in outline with few small cytoplasmic processes. The nucleus was eccentrically placed and was having 1-2 lobes. The
cytoplasmic granules were extremely large than those of (1.2 µ to 1.9 µ) neutrophils and eosinophils (Fig. 6). Granules were homogenously electron dense and mostly oval in shape. The mitochondria, Golgi apparatus and vacuoles were clearly visible in the cytoplasm (Fig. 6). Yamada and Sonoda (1970) reported three types of granules in sheep basophils. Singh (2000) observed that in the buffalo calves cytoplasm of basophils showed granules. Mehta et al. (2012) stated that in pig basophils the cytoplasmic granules were comparatively less when compared with neutrophils and eosinophils. One type of cytoplasmic granules was electron lucent, very small in size and few in number. The second type of granules which was highly electron dense, maximum in population and showed pleomorphism.

REFERENCES


