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Morphological identification and characterization of *Trichostrongylus* spp. isolated from the gastrointestinal tract of a goat

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Abstract

Trichostrongylus spp. are among the most important gastrointestinal nematodes infecting domestic ruminants and are responsible for substantial economic losses due to reduced productivity, poor growth, impaired feed conversion, and decreased reproductive performance. Accurate morphological identification remains fundamental for diagnosis and epidemiological investigations. The present study was undertaken to investigate the morphological characteristics of *Trichostrongylus* spp. recovered from a naturally infected goat. The abomasum and small intestine were collected from a 5-year-old female goat at a local slaughterhouse in Datia, Madhya Pradesh, India. The organs were examined for adult nematodes, and approximately 40 worms were recovered by washing, sieving, and mucosal scraping. The specimens were thoroughly washed, cleared in lactophenol, and examined under a light microscope using standard taxonomic keys. Adult male worms measured 3.2-5.8 mm in length and 0.06-0.10 mm in width, whereas females measured 4.0-7.5 mm in length and 0.07-0.12 mm in width. Both sexes exhibited a slender, thread-like body with finely transversely striated cuticle and tapering extremities. The anterior end lacked lips and possessed a minute buccal cavity opening into a cylindrical oesophagus. Male worms were characterized by a well-developed copulatory bursa with paired equal spicules and a gubernaculum, while females showed a straight to slightly curved posterior extremity with the vulva located in the posterior one-third of the body and a uterus containing numerous thin-shelled oval eggs. The observed morphometric and morphological features were consistent with published descriptions of *Trichostrongylus* spp. The study confirms that conventional morphological examination remains a reliable and economical method for identifying *Trichostrongylus* spp., although integration with molecular techniques would improve species-level identification and strengthen epidemiological and parasite control programmes.

Keywords: *Trichostrongylus* spp., goat, morphology, gastrointestinal nematode, copulatory bursa, abomasum, small intestine, trichostrongylosis

Introduction

Trichostrongylus spp. are among the most prevalent gastrointestinal nematode parasites infecting the abomasum and small intestine of domestic ruminants, including sheep, goats, and cattle, irrespective of age, sex, or breed. These parasites are widely distributed throughout tropical, subtropical, and temperate regions and continue to cause considerable economic losses through reduced weight gain, poor feed conversion efficiency, decreased milk and wool production, impaired reproductive performance, and increased susceptibility to secondary infections (Soulsby, 1982; Bowman, 2002; Taylor *et al.*, 2016) [8, 1, 10]. Despite decades of research on their epidemiology and control, *Trichostrongylus* spp. remain a major constraint to sustainable small ruminant production worldwide due to their widespread occurrence and increasing anthelmintic resistance (Sutherland and Scott, 2010; Kaplan and Vidyashankar, 2012) [9, 5].

The genus *Trichostrongylus* comprises numerous species of veterinary and public health importance, including *T. colubriformis*, *T. axei*, *T. vitrinus*, *T. capricola*, *T. probolurus*, and *T. rugatus*, which primarily infect domestic and wild ruminants, while several species are also recognized as zoonotic parasites capable of infecting humans (Taylor *et al.*, 2016; CDC, 2022) [10, 2]. Infection with *Trichostrongylus* spp., commonly referred to as trichostrongylosis, results in parasitic gastroenteritis characterized by damage to the abomasal and intestinal

mucosa, leading to anorexia, diarrhoea, weight loss, hypoproteinaemia, reduced nutrient absorption, poor body condition, anaemia in heavy infections, and decreased production efficiency. Severe infections, particularly in young or immunocompromised animals, may cause enteritis, dehydration, stunted growth, and occasionally mortality (Soulsby, 1982; Bowman, 2002; Taylor *et al.*, 2016) [8, 1, 10].

The life cycle of *Trichostrongylus* spp. is direct and does not require an intermediate host. Adult worms inhabiting the abomasum or small intestine produce eggs that are passed in the faeces, where they hatch and develop through free-living first-stage (L1) and second-stage (L2) larvae to the infective third-stage (L3) larvae under favourable environmental conditions. Grazing animals acquire infection by ingesting infective L3 larvae present on contaminated pasture. Following exsheathment in the gastrointestinal tract, larvae penetrate the mucosa of the abomasum or small intestine, where they develop into fourth-stage larvae (L4) and immature adults before emerging into the lumen and maturing into egg-producing adults (Levine, 1980; Taylor *et al.*, 2016) [6, 10]. The feeding activity and mucosal invasion of developing larvae result in epithelial damage, villous atrophy, inflammation, impaired digestion, and malabsorption, thereby contributing to the clinical manifestations of trichostrongylosis.

India possesses one of the world's largest populations of sheep and goats, which play a vital role in rural livelihoods, food security, and the national economy. Consequently, gastrointestinal nematode infections, including trichostrongylosis, represent a major impediment to livestock productivity and profitability (Government of India, 2012) [4]. Although broad-spectrum anthelmintics have substantially improved parasite control over the past several decades, the widespread emergence of anthelmintic resistance among *Trichostrongylus* spp. has become a serious challenge to sustainable parasite management (Kaplan and Vidyashankar, 2012; Sutherland and Scott, 2010) [5, 9]. This has stimulated increasing interest in integrated parasite control strategies, including targeted selective treatment, pasture management, biological control, molecular diagnostics, vaccine development, genomic approaches, and selective breeding for genetically resistant animals (Taylor *et al.*, 2016) [10].

Future sustainable management of *Trichostrongylus* infections will depend upon a comprehensive understanding of the parasite's morphology, life cycle, epidemiology, pathogenicity, molecular biology, and host immune responses. Therefore, the present study was undertaken to investigate and describe the morphological characteristics of *Trichostrongylus* spp. recovered from naturally infected domestic ruminants, thereby contributing to their accurate identification and improved understanding of this economically important gastrointestinal nematode.

Materials and Methods

The abomasum and small intestine (duodenum, jejunum, and ileum) were collected from a 5-year-old female goat at a local slaughterhouse in Datia, Madhya Pradesh, during May, 2026. Immediately after collection, the organs were transported to the laboratory and examined for the presence

of gastrointestinal nematodes. The external surfaces of the abomasum and small intestine were carefully inspected for gross pathological changes associated with parasitic infection, including congestion, haemorrhages, oedema, thickening of the intestinal wall, catarrhal inflammation, ulceration, or other visible lesions.

The abomasum and small intestine were opened longitudinally using sterile scissors, and their luminal contents were collected separately into clean containers. The mucosal surfaces were gently scraped with a glass slide to recover worms embedded within the mucus and attached to the mucosa. The contents and mucosal scrapings were diluted with physiological saline, thoroughly mixed, and passed through a sieve of appropriate mesh size to recover adult nematodes. The washing and sieving procedure was repeated several times until no additional worms were recovered. Approximately 40 adult *Trichostrongylus* worms were collected and washed repeatedly with distilled water followed by phosphate-buffered saline (PBS) to remove adhering mucus, debris, and intestinal contents.

The recovered worms were subsequently transferred to lactophenol solution and kept overnight at 4 °C for clearing. Cleared specimens were examined under a light microscope at 10× and 40× magnifications for morphological identification. Species identification was carried out using standard taxonomic keys based on characteristic morphological features, including body size and shape, cephalic extremity, cuticular striations, oesophageal morphology, cervical papillae, excretory pore, and the morphology of the posterior extremity. Sex differentiation was performed by examining reproductive structures, including the copulatory bursa, spicules, gubernaculum, and bursal rays in males, and the position of the vulva, ovijector, tail, and posterior extremity in females. The preparation for morphological identification of the recovered specimens was performed according to the descriptions provided by Soulsby (1982) [8], Bowman (2002) [1], Taylor *et al.* (2016) [10], Mishra *et al.* (2024) [7], and Gibbons (2010) [3].

Results

Adult specimens recovered from the abomasum and small intestine were identified as *Trichostrongylus* spp. based on their characteristic morphological features. The adult male worms measured 3.2-5.8 mm in length and 0.06-0.10 mm in width, whereas the adult females measured 4.0-7.5 mm in length and 0.07-0.12 mm in width. Both sexes were slender, delicate, thread-like nematodes with tapering anterior and posterior extremities and a smooth, finely transversely striated cuticle.

The anterior extremity was bluntly rounded and devoid of lips, terminating in a minute buccal cavity that opened directly into a cylindrical muscular oesophagus (Figure 1). The oesophagus occupied approximately one-fifth of the body length and gradually merged with the intestine without a distinct posterior bulb. The intestine appeared as a simple straight tube extending from the oesophago-intestinal junction to the posterior end of the body. The cuticle exhibited fine transverse striations throughout its length, and no cervical vesicle or buccal capsule was observed, which is characteristic of members of the family *Trichostrongylidae*.



Fig 1: Anterior end of *Trichostrongylus* spp.



Fig 2: Posterior end of Male *Trichostrongylus* spp.



Fig 3: Posterior end of Female *Trichostrongylus* spp.



Fig 4: Egg arrangement in pole to pole.

Male worms possessed a well-developed copulatory bursa at the posterior extremity supported by characteristic bursal rays (Figure 2). The copulatory bursa consisted of paired lateral lobes and a comparatively smaller dorsal lobe. Two equal, slender, brownish spicules measuring 0.10-0.18 mm in length were present and projected through the cloacal opening. A small gubernaculum was observed between the spicules in some specimens. The morphology of the copulatory bursa, arrangement of the bursal rays, and shape of the spicules served as important diagnostic features for species identification.

In contrast, the posterior extremity of female worms was straight or only slightly curved, tapering gradually to a pointed tail without a copulatory bursa (Figures 3). The vulva was situated in the posterior one-third of the body, and the uterus contained numerous thin-shelled, oval eggs arranged in rows (Figure 4). These morphological characteristics were consistent with those described for *Trichostrongylus* spp. by Soulsby (1982)^[8], Bowman (2002)^[1], Gibbons (2010)^[3], and Taylor *et al.* (2016)^[10].

Discussion:

The present study successfully identified adult *Trichostrongylus* spp. recovered from the abomasum and small intestine of a naturally infected goat based on their characteristic morphological features. Morphological identification remains the primary and most practical approach for the diagnosis of gastrointestinal nematodes, particularly in regions where molecular diagnostic facilities are limited (Soulsby, 1982; Bowman, 2002)^[8, 1]. The overall morphology observed in the present investigation was consistent with the diagnostic characteristics described for members of the family *Trichostrongylidae* by Soulsby (1982)^[8], Gibbons (2010)^[3], and Taylor *et al.* (2016)^[10].

The adult worms were slender, thread-like nematodes with finely transversely striated cuticle and tapering extremities, which are considered distinguishing features of the genus *Trichostrongylus*. The body measurements recorded in the present study were comparable with those reported by Levine (1980)^[6], Soulsby (1982)^[8], and Taylor *et al.* (2016)^[10], although slight variations in body length and width have been reported among different *Trichostrongylus* species and geographical isolates. Such morphometric variations may be attributed to differences in host species, nutritional status, age of the parasite, environmental conditions, and fixation or clearing techniques used during specimen preparation (Gibbons, 2010)^[3].

The anterior extremity lacked lips and possessed a minute buccal cavity leading directly into a cylindrical muscular

oesophagus, a feature characteristic of trichostrongylid nematodes. Similar observations have been reported by Bowman (2002) ^[1] and Taylor *et al.* (2016) ^[10], who emphasized that the reduced buccal cavity and simple oesophagus are adaptations to the parasitic mode of life within the gastrointestinal tract. The absence of a buccal capsule and cervical vesicle further differentiated the recovered specimens from several other strongylid nematodes infecting domestic ruminants.

The posterior extremity of male worms exhibited a well-developed copulatory bursa supported by characteristic bursal rays together with paired equal spicules, which constitute the most reliable taxonomic features for identification of *Trichostrongylus* species (Gibbons, 2010) ^[3]. Although only general morphological identification to the genus level was undertaken in the present study, the morphology of the copulatory bursa and spicules corresponded closely with previous descriptions of *Trichostrongylus* spp. reported from small ruminants (Soulsby, 1982; Taylor *et al.*, 2016) ^[8, 10]. Minor variations in spicule length have been documented among species such as *T. colubriformis*, *T. vitrinus*, and *T. axei*, highlighting the importance of detailed morphometric analysis and molecular confirmation for accurate species-level identification (Gibbons, 2010) ^[3].

Female worms were characterized by a straight or slightly curved posterior extremity, with the vulva located in the posterior one-third of the body and a uterus containing numerous thin-shelled, oval eggs. These observations agree with the classical descriptions of *Trichostrongylus* spp. provided by Levine (1980) ^[6], Bowman (2002) ^[1], and Taylor *et al.* (2016) ^[10]. The presence of numerous embryonated eggs within the uterus further indicated that the recovered specimens were mature and reproductively active.

Overall, the morphological characteristics observed in the present study confirmed the identity of the recovered nematodes as *Trichostrongylus* spp. Although conventional morphology remains indispensable for routine diagnosis, accurate differentiation among closely related *Trichostrongylus* species is often difficult because of overlapping morphometric characters. Therefore, the integration of detailed morphological examination with molecular techniques such as PCR amplification and sequencing of the internal transcribed spacer (ITS) or mitochondrial cytochrome c oxidase subunit I (cox1) genes would provide more precise species identification and improve epidemiological investigations. Such integrated approaches will enhance our understanding of parasite diversity, transmission dynamics, and the development of effective control strategies against trichostrongylosis in domestic ruminants.

Conclusion

The present study confirmed the identification of *Trichostrongylus* spp. recovered from the abomasum and small intestine of a naturally infected goat based on their characteristic morphological features. The observed morphometric measurements and diagnostic characteristics, including the slender thread-like body, simple anterior extremity, cylindrical oesophagus, well-developed copulatory bursa with paired spicules in males, and the posteriorly located vulva in females, were consistent with standard taxonomic descriptions reported in the literature.

These findings demonstrate that detailed morphological examination remains a reliable and cost-effective method for the identification of *Trichostrongylus* spp. in routine parasitological investigations. Nevertheless, complementary molecular techniques would further improve species-level identification and contribute to better epidemiological surveillance and the development of effective control strategies against trichostrongylosis in domestic ruminants.

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