**Effect of genetic and non-genetic factor on parasitic load in Osmanabadi goat of arid and semiarid region of Maharashtra**

**Abstract**

Osmanabadi goat is reared in arid and semi arid region of India and play a role in economy of rural livelihood. Small ruminant practices in India face major challenge of parasitic infestation hence, present study was carried out to see the effect of different genetic and non genetic factors on parasitic load of these goats in Udgir tehsil of Latur district of Maharashtra. The **variation** due to season, age, sex, farm and genotype of *TaqI* locus of *MHC DRB1* gene on **Fecal Egg Count (FEC)** and Haemonchus **Egg Count (HEC) in the flocks was studied. The study comprised of 84 animals and it was seen that the season and genotype were the significant factors affecting FEC and HEC in these flocks reared in organized and non-organized farm.** The **BB genotype** had the lowest **FEC** suggesting that the BB genotype might be resistant to parasitic load.

**Key words**:- Goat, Osmanabadi, FEC, Haemonchus, season, variation, HEC

**Introduction**

Gastrointestinal nematodes (GINs) create a major threat to the production performance of small ruminants. Several studies have reported genetic variation for resistance to parasites (Prince *et al*., 2010; Karlsson and Greeff, 2012; Assenza *et al*., 2014; Brown and Fogarty, 2017; Ngere *et al*., 2018). Selection of animals for parasitic resistance is the key for breeding healthy animals and to avoid losses incurred due to parasitic infestation. Genetic selection is expected to alter the population’s genetic structure for the long term (Gowane *et al*., 2019) and thus can be considered as the effective way to deal with the problem.

Parasitic resistance is however a threshold trait with the underlying variable associated with fecal egg count (FEC). Genetic parameters for FEC have been estimated by different researchers. The heritability estimates for FECs ranges from low to moderate (Boareki *et al*., 2021; Ngere *et al*., 2018; Pollott and Greeff, 2004, *etc*.) and are subjected to variation because of many genetic and non genetic factors (Dappawar *et al*., 2018; Idris *et al*., 2012; McManus *et al*., 2009). In present study, the effect of factors like age, sex, season, birth type and genotype associated with *TaqI DRB1* locus in *exon2* of *caprine MHC* (Major histocompatability complex) were studied to associate with FEC and Haemonchus **Egg Count (HEC)** in Osmanabadi goats of arid and semiarid region of Maharashtra state.

**Materials and Methods**

***Animals***

The study was conducted for a period of one year in 2024-25. Initially a total of 100 unrelated Osmnabadi goats reared at Instructional Livestock Farm Complex (ILFC), College of Veterinary and Animal Sciences (COVAS), Udgir and from farmer’s flock at Navandi, Udgir were part of this study. Subsequently, due to mortality and sale of kids, the number was reduced to 84.

***Data collection***

Hence the data pertaining to age of animals, sex and litter size in last kidding was collected for 84 goats. Data was collected based on records available at the ILFC and information given by the farmer. The seasons of the year were classified as Monsoon (June to September), winter (October to January) and summer (February to May) (Kuchai *et al.,* 2011; Sivajothi and Reddy, 2018 and Dappawar *et al*., 2018).

Age was confirmed through records and dentition. The female animals giving birth to single kid were classified and recorded as singlet while those giving birth to more than one kids were recorded as multiple birth. For kids and males history of born as singlet or in multiple births was recorded.

***Faecal egg count***

FEC was determined using Stoll’s Dilution Method (Soulsby, 1982). Sample of faeces (1 gm) was mixed with N/10 NaOH solution, and the suspension was filtered to remove coarse fibers. A 0.15 ml aliquot of the prepared suspension was placed on a glassslide, covered with a cover slip, and examined under a microscope at 10X magnification (plate 4.6). The total number of eggs observed was counted, and the FEC was calculated by multiplying the count by 100.The range of FEC observed in the study period was zero to 4500 eggs per gram (epg). The Haemonchus egg count (HEC) was also determined using a similar procedure to FEC, but with a specific focus on counting eggs of Haemonchus species.

***Genotyping***

Data on RFLP variants for *Taq1* locus of *Caprine-MHCDRB1 exon 2* of each goat was considered for the purpose of analysis. The genomic DNA was isolated from blood samples by Phenol-chloroform extraction method (Clamp *et al*., 1993). Sequence specific primers reported by Kush *et.al.* 2015 were utilized to amplify *exon 2* of *DRB1* gene of *caprine-Mhc*.

The polymerase chain reaction (PCR) was carried out in a total volume 20 μl [100 ng template DNA, 10X buffer with Mgcl2 2 μl, 2.5 Mm dNTPs (100 µM each) 0.4 μl, forward primer and reverse primer (20 pmol / μl) 0.5 μl each and *Taq* DNA polymerase 0.3 μl]. The digestion of PCR product was carried out in 15ul volume [PCR product 10.0ul, 1.5 ul of 10X Buffer (Thermo Scientific), 5 Unit *Taq1*restriction enzyme and water]. The reaction mixture was incubated at 650C for overnight and separated by electrophoresis on 3 % agarose gel (Sigma).

***Statistical analysis***

Descriptive statistical analysis was performed. Continuous measurements are presented as the Mean ± SE. Analysis of Variance (ANOVA) was used to compare variables across different categories.

**Results and Discussion**

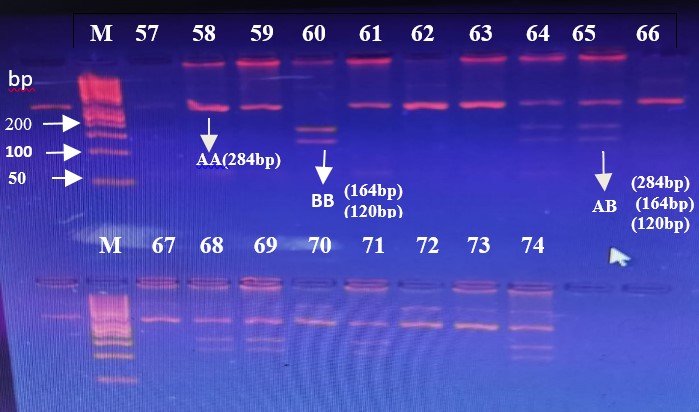
The amplified PCR products of the *DRB1* gene *exon 2* (284 bp) (fig 1) population revealed three genotypes: AA, AB, and BB (fig 2). The range of FEC and HEC observed in the study period was zero to 4500 and zero to 1100 respectively. Values of FEC and HEC across different genetic and non-genetic factors are represented in table 1.

**Fig 1. PCR product of *exon 2* of *DRB1* gene of *caprine-Mhc***



(M- 50bp ladder, lane 1-10- PCR product of 284bp)

**Fig 2. PCR- RFLP variants of *exon 2* of *DRB1* gene of *caprine-Mhc***



(M- 50bp ladder, lane 57-74- digested PCR product of showing variants AA, AB and BB)

**Table 1. Values of FEC and HEC across different variables in different seasons.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Group** | **N** | **Summer** | | **Monsoon** | | **Winter** | |
| **Age Group** | **FEC** | **HEC** | **FEC** | **HEC** | **FEC** | **HEC** |
| Adult | 36 | 386.11 ± 49.31 | 152.78 ± 19.71 | 930.55 ± 97.66 | 355.56 ± 43.41 | 325 ± 97.65 | 125 ± 43.41 |
| Kid | 21 | 285.71 ± 44.73 | 42.86 ± 4.75 | 1300 ± 60.89 | 295.24± 60.89 | 380.95 ± 106.09 | 57.14 ± 60.89 |
| Young | 27 | 518.52 ± 161.54 | 162.96 ± 39.64 | 1229.62 ± 137.84 | 429.63 ± 71.04 | 414.814 ± 137.84 | 151.85 ± 69.89 |
| **Sex** | Female | 62 | 448.3 ± 78.2033 | 133.33 ± 20.95 | 1105 ± 85.02 | 375 ± 20.95 | 366.67 ± 85.02 | 126.67 ± 20.95 |
| Male | 24 | 291.66 ± 38.5033 | 116.67 ± 24.57 | 1154.17 ± 147.31 | 337.5 ± 76.09 | 370.83 ± 147.31 | 91.66 ± 76.09 |
| **Birth Type** | Single | 21 | 371.42 ± 81.69 | 119.05 ± 29.77 | 1085.71 ± 159.65 | 400 ± 65.39 | 252.38 ± 159.65 | 95.24 ± 65.39 |
| Twin | 51 | 439.22 ± 87.31 | 135.29 ± 23.23 | 1162.75 ± 87.66 | 378.43 ± 46.80 | 401.96 ± 87.66 | 121.57 ± 46.8 |
| Triplet | 12 | 308.33 ± 58.33 | 116.66 ± 32.17 | 991.66 ± 230.1 | 291.66 ± 85.69 | 425 ± 230.1 | 133.33 ± 85.68 |
| **Farm** | ILFC | 55 | 478.18 ± 83.914 | 152.77 ± 22.6 | 1119.05 ± 88.30 | 364.28 ± 307.81 | 414.54 ± 88.30 | 132.72 ± 41.51 |
| Navandi | 29 | 262.07± 36.61 | 216.67 ± 18.62 | 1213.79 ± 708.48 | 400 ± 334.88 | 279.31 ± 708.48 | 86.21 ± 708.48 |
| **Genotype** | AA | 33 | 454.55 ± 52.72 | 128.12 ± 19.99 | 1119.047 ± 167.11 | 436.363 ± 167.11 | 454.54 ± 107.119 | 148.48 ± 53.98 |
| AB | 36 | 425 ± 127.74 | 152.77 ± 32.36 | 930.5 ± 110.7095 | 320 ± 56.1383 | 347.22 ± 110.709 | 100 ± 56.14 |
| BB | 15 | 240 ± 39.99 | 80 ± 27.95 | 966.66 ± 170.61 | 326.66 ± 72.0229 | 226.66 ± 170.61 | 86.66 ± 72.02 |

***Effect of season on FEC and HEC***

Highest FEC values were recorded during the monsoon season, with a maximum of 2800 and a minimum of 300 (mean: 1119.047 ± 73.44), followed by the summer season, where FEC ranged from a minimum of 100 to a maximum of 1900 (mean: 403.5714 ± 57.29), and the lowest values in the winter season, with FEC ranging from a minimum of 0 to a maximum of 1100 (mean: 116.66 ± 28.94). The FEC in monsoon season was significantly higher when compared to other season *viz*., winter and summer as also reported earlier (**Dixit *et al*. (2017);** Singh *et al*. (2013)**; Khajuria *et al*. (2013); Hassan *et al*. (2011) and Sutar *et al*. (2010))**

HEC was highest in the monsoon, with a range from a minimum of 0 to a maximum of 1600 (367.469 ± 34.59). The summer season showed lower HEC values, with a range from a minimum of 0 to a maximum of 1000 (mean: 128.5714 ± 16.47) and the winter season had the lowest values, ranging from a minimum of 0 to a maximum of 900 (mean: 116.66 ± 17.091) mirroring the findings by Rajpoot *et al*. (2017), Khajuria *et al*. (2013) and Hassan *et al.* (2011).

***Effect of age on FEC and HEC***

The study found age-related differences in both Fecal Egg Count (FEC) and Heamonchus Egg Count (HEC) across seasons (p > 0.05NS). Adults showed lower FEC values compared to younger goats, reflecting partial immunity developed over time. In the summer, adult FEC was 386.11 ± 49.305, which decreased in winter. Kids had the lowest FEC in the summer (285.71 ± 44.87), but their FEC increased in the monsoon (1300 ± 60.89), highlighting their increased susceptibility to parasitic infections during wetter seasons. Young goats showed intermediate FEC values, with a peak in the monsoon (1229.62 ± 137.84).

In terms of HEC, adults exhibited the lowest values in all seasons, indicating stronger immunity to infections. Kids had the lowest HEC in the summer (42.85 ± 4.754) but saw a significant increase during the monsoon (295.238 ± 60.897). Young goats showed moderate HEC values, with a peak in the monsoon (429.629 ± 71.040). Results are comparable with Khajuria *et al.* (2013).Although age-related variations in FEC and HEC were observed, these differences did not reach statistical significance.

***Effect of sex on FEC and HEC***

Female goats generally exhibited higher FEC and HEC compared to males, especially during the monsoon season. In the monsoon, females had a mean FEC of 1105 ± 85.02 and HEC of 375 ± 20.95, while males had FEC of 1154.17 ± 147.31 and HEC of 337.50 ± 76.09. Similar trends were observed in summer, with females showing higher FEC and HEC values. The difference was less pronounced in winter. **Kalwaghe *et al.* (2019) and Hassan *et al*. (2011)** similarly has noted that **female goats** tend to exhibit a greater susceptibility to parasitic infections, including gastrointestinal nematodes, when compared to their male counterparts possibly due to physiological differences such as hormonal variations that could impact immune function.

***Effect of birth type FEC and HEC***

The study found no significant effect of birth type (single, twin, or triplet) on FEC and HEC in goats across seasons. In both the monsoon and winter seasons, twin-born goats had the highest FEC and HEC, followed by single- and triplet-born goats. However, the differences were not statistically significant (p > 0.05), indicating that birth type had a minimal effect on parasite loads. This observation is consistent with findings in Black Bengal goats (**Hassan *et al*,. 2011).**

***Effect of farm on FEC and HEC***

The study compared FEC and HEC between ILFC and Navandi Farms across different seasons. In the summer, ILFC had higher FEC (478.18 ± 83.91) and HEC (152.77 ± 22.60), while Navandi farm had lower FEC (262.07 ± 36.61) but higher HEC (216.67 ± 18.62). During the monsoon, both farms showed high parasite levels, with ILFC showing lower FEC and HEC compared to Navandi. In winter, ILFC exhibited reduced FEC (414.54 ± 88.30) and HEC (132.72 ± 41.51), while Navandi had a lower FEC (279.31 ± 708.48) but similar HEC (86.21 ± 708.48). These findings highlight that both **seasonal changes** and **farm management** practices can impact the prevalence of gastrointestinal parasites, including ***Haemonchus***, on farms. Factors such as **sanitation practices, grazing management**, and **environmental conditions** may contribute to the differences observed in parasitic infections between the two farms. Though, these differences were statistically non-significant.

***Effect of genotypes on FEC and HEC***

The analysis of FEC and HEC across three genotypes (AA, AB, BB) revealed significant differences in parasitic load. In summer, the AA genotype showed the highest FEC (454.54 ± 52.72) and HEC (128.12 ± 19.99), while the BB genotype exhibited the lowest FEC (240 ± 39.99) and HEC (80 ± 27.94), indicating better resistance in BB goats (p < 0.01). During the monsoon, AA goats continued to show the highest FEC (1119.04 ± 167.11) and HEC (436.36 ± 167.11), suggesting increased susceptibility to parasitic infections. In winter, AA goats again exhibited significantly higher FEC (454.54 ± 107.12) and HEC (148.48 ± 53.97), while BB goats consistently showed the lowest values (FEC: 226.66 ± 170.61, HEC: 86.66 ± 72.02), supporting the idea that BB genotype is associated with lower parasitic burdens. The BB genotype demonstrated significantly (p< 0.01\*\*) better resistance or lower susceptibility to gastrointestinal parasites in comparison to the AA and AB genotypes across all seasons as also evident in studies conducted by different researchers (Ahmed *et al*., 2006 and Sbalamurugan *et al.*, 2021).

**Conclusions**

Production performance in farm animals is governed by complex traits that are threshold in nature and cannot be measured directly. Parasitic resistance is one of them and FEC is considered as an indicator of this trait in livestock. Several genetic and non genetic factors like season, age, sex, farm, genotype and even birth type affect the FEC in small ruminants. Based on the findings in present study, it is recommended that goat farmers implement targeted control measures during the monsoon season to manage parasitic infections effectively. Age-appropriate deworming and vaccination strategies, alongside genetic selection for disease-resistant genotypes, should be incorporated into goat farming practices to reduce economic losses due to parasitic diseases.

**References**

Ahmed, S. and Othman, O. E. (2006). A PCR-RFLP method for the analysis Egyptian goat MHC class II DRB gene. *Biotechnology*, ***5***(1), 58-61.

Assenza, F., Elsen, J.M., Legarra, A., Carré, C., Sallé, G., Robert-Granié, C. and Moreno, C.R. (2014). Genetic parameters for growth and faecal worm egg count following Haemonchus contortus experimental infestations using pedigree and molecular information. *Genetics Selection Evolution*, 46, 1–9.

Boareki, M.N., Flavio, S., Schenkel, O.W., Aroa Suarez-Vega, Delma, K., Cánovas, A. (2021). Comparison between methods for measuring fecal egg count and estimating genetic parameters for gastrointestinal parasite resistance traits in sheep. Journal of Animal Science, 99(12), 341

Brown, D.J. and Fogarty, N.M. (2017). Genetic relationships between internal parasite resistance and production traits in Merino sheep. *Animal Production Science*, 57, 209–215.

Clamp, M., Jackson, B. and Smith, J. (1993). A modified phenol-chloroform extraction method for genomic DNA isolation from human blood. Journal of Molecular Biology*,* 212 (3), 311-317.

Dappawar, M.K., Khillare, B.S., Narladkar , B.W. and Bhangale, G.N. (2018). Prevalence of gastrointestinal parasites in small ruminants in Udgir area of Marathwada. *Journal of Entomology and Zoology Studies*, 6(4), 672-676

Dixit, A. K., Das, G., and Baghel, R. P. S. (2017). Gastrointestinal helminthosis: prevalence and associated determinants in goats of Jabalpur, India. *Journal of parasitic diseases*, 41, 414-416

Gowane, G.R., Swarnkar, C.P., Misra, S.S., Kumar, R., Kumar, A. and Prince, L.L.L. (2019). Genetic parameter estimates for fecal egg counts and their relationship with growth in Avikalin and Malpura sheep. *Animals*, 13(9), 1788-1796.

Hassan, M. M., Hoque, M. A., Islam, S. K. M. A., Khan, S. A., Roy, K., and Banu, Q. (2011). A prevalence of parasites in black bengal goats in Chittagong, Bangladesh. *Int. J. Livest. Prod*, ***2***(4), 40-44

Idris, A., Eva, M., Birgit, S. and Matthias, G. (2012). Gastrointestinal nematode infections in German sheep. *Parasitology Research*, 110, 1453-1459

Kalwaghe, S. T., Palampalle, H. Y., Narladkar, B. W., Zende, R. J., Gandge, R. S., and Ingle, S. A. (2019). Influence of prevailing weather parameters on population dynamics of gastrointestinal parasites in different geographical regions of Maharashtra. *Journal of Entomology and Zoology Studies,***7**(6), 767-771

Karlsson, L.J. and Greeff, J.C. (2012). Genetic aspects of sheep parasitic diseases. *Veterinary Parasitology*, 189, 104–112.

Khajuria, J. K., Katoch, R., Yadav, A., Godara, R., Gupta, S. K., and Singh, A. (2013). Seasonal prevalence of gastrointestinal helminths in sheep and goats of middle agro-climatic zone of Jammu province. *Journal of parasitic diseases*, 37, 21-25

Kuchai, J.A., Chshti, M.Z., Zaki, M.M., Ahmad, J., Rasool, M., Dar, S.A. and Tak, H. (2011). Epidemiology of helminth parasites in small ruminants of ladakh, india. *Online Journal of Animal and Feed Research,* 5, 239-242

Kush,S., Pushpendra, K., Nihar S.R., Amolkumar and Amit kumar.(2015). Genotyping of major histocompatibility complex Class II DRB gene in Rohilkhandi goat by polymerase chain reaction-restriction fragment length polymorphism and DNA sequencing. *Veterinary World*, 8(10), 1183–1188.

McManus, C., Helder, L., Samuel, R.P., Amaury, A.D.O., Hymerson, C.A. and Cristiano, B.D.M. (2009).Genetic factors of sheep affecting gastrointestinal parasite infections in the Distrito Federal, Brazil. *Veterinary Parasitology*, 166, 308-313

Ngere, L., Burke, J.M., Morgan, J.L.M., Miller, J.E. and Notter, D.R. (2018). Genetic parameters for fecal egg counts and their relationship with body weights in Katahdin lambs. *Journal of Animal Science*, 96, 1590–599.

Pollott G. E. and Greeff J. C. (2004). Genotype × environment interactions and genetic parameters for fecal egg count and production traits of Merino sheep. Journal of Animal Science, 82 (10), 2840–2851

Prince, L.L.L., Gowane, G.R., Swarnkar, C.P., Singh, D. and Arora, A.L. (2010). Estimates of genetic parameters for faecal egg count of Haemonchus contortus infection and relationship with growth traits in Avikalin sheep. *Tropical Animal Health and Production*, 42, 785–791.

Rajpoot, J., Shukla, S., Jatav, G. P., Garg, U. K., and Agrawal, V. (2017). Coproculture study of strongyle infection of goats from Malwa region of Madhya Pradesh. *Journal of Entomology and Zoology Studies*, 5(5), 876-878.

Singh, V., Varshney, P., Dash, S. K., and Lal, H. P. (2013). Prevalence of gastrointestinal parasites in sheep and goats in and around Mathura, India. *Veterinary World*, **6**(5), 260.

Sivajothi, S. and Reddy, B. (2018). Seasonal Prevalence of Gastrointestinal Parasites of Small Ruminants in YSR Kadapa District of Andhra Pradesh, Indiash, India. *InternationalJournalofLivestockResearch*. 8(1), 184-189.

Soulsby, E.J.L. (1982). Helminths, arthropods and protozoa of domesticated animals. 7th edition ELBS and Bailliere Tindall, London. pp 765-768

Sutar, A. U., and Khan, M. R. (2011). Seasonal prevalence of gastrointestinal parasites in sheep of rural areas of Ahmednagar district of Maharashtra. *Asian Journal of Animal Sciences*, 6, 21-22.

Sbalamurugan, T., Kumar, P., Shrivastava, K., Mishra, C., Prakash, O., Kumar, A., andVelusamy, S. (2021). Caprine MHC gene polymorphism and its association with endoparasitic infestation (Haemonchuscontortus) in Indian goat breeds. *Turkish Journal of Veterinary & Animal Sciences*, 45(1), 93-100.