Unlocking the Genomic Potential in Indian Goats: Toward Enhanced Production

ICAR-National Bureau of Animal Genetic Resources

GOATS IN INDIA

TOTAL GOAT POPULATION-148.88 Million (10.14% increase)

39 registered breeds + several lesser known populations

	2022-23	Share	2050
MEAT	1.4 million tonnes	14.47%	2.03 million tonnes
MILK	7.6 million tonnes	3.3%	increasing

Highly diverse breeds

Pashmina fibre (12 µ)

best dairy goat of South East Asia and is tallest goat breed of the country.

Prolificacy & skin (Av litter size-1.75)

Traits of interest

- Milk production
- Fibre quality
- Prolificacy
- Chevon production
- Growth rate
- Disease resistance

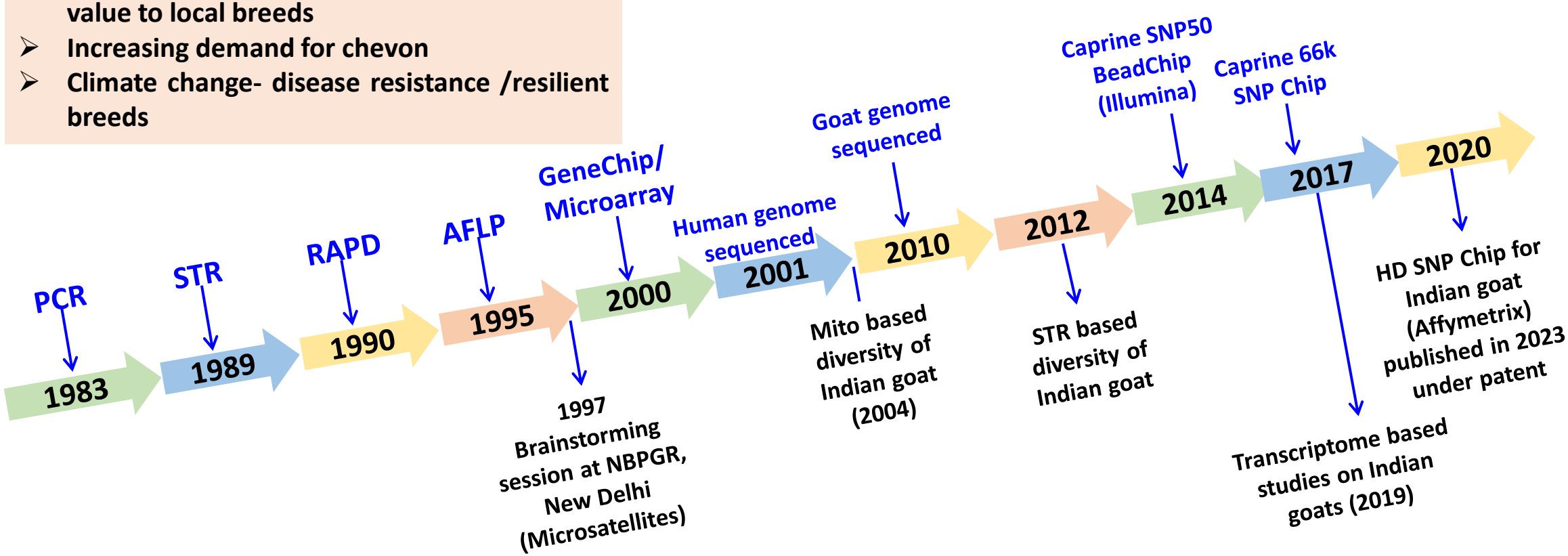
Unlocking the hidden genetic potential of these breeds will provide an understanding of their adaptability and productivity traits, leading to more targeted and effective breeding strategies to boost production.

THREATS AND CHALLENGES

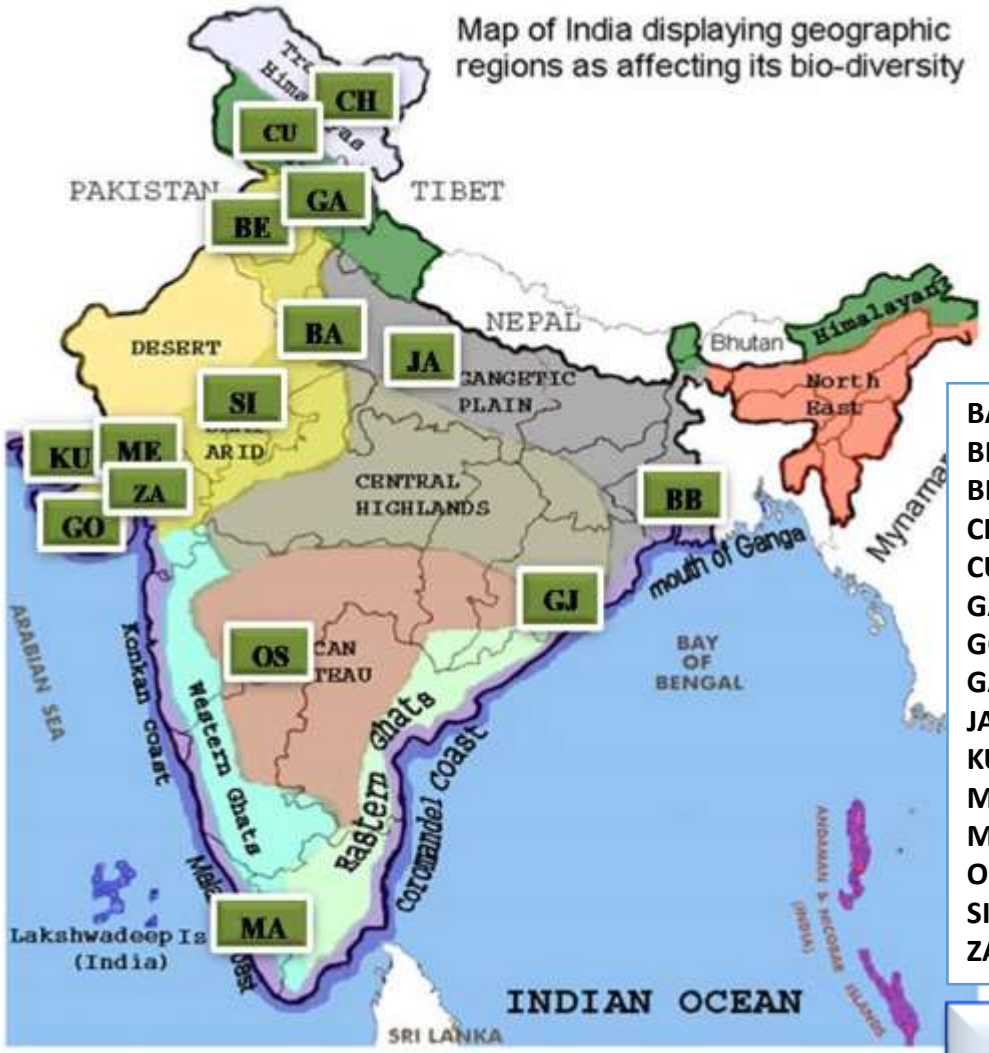
- Low productivity of indigenous breeds
- Admixture/Breed composition
- Identifying selection traits
- Identifying logical breeding objectives
- Maximizing genetic gain at an acceptable inbreeding rate (selection within breeds).
- Economic sustainability - Adding market value to local breeds
- Increasing demand for chevon
- Climate change- disease resistance /resilient breeds

OPPORTUNUTIES AND STRENGTHS

- Vast caprine biodiversity
- Genetic potential unexplored
- Phenotype recording
- Omics to fast track genetic information
- Informed breeding strategies based on integrated data (phenotypic and genomic)



Design and development of HD SNP Chip for Indian goats



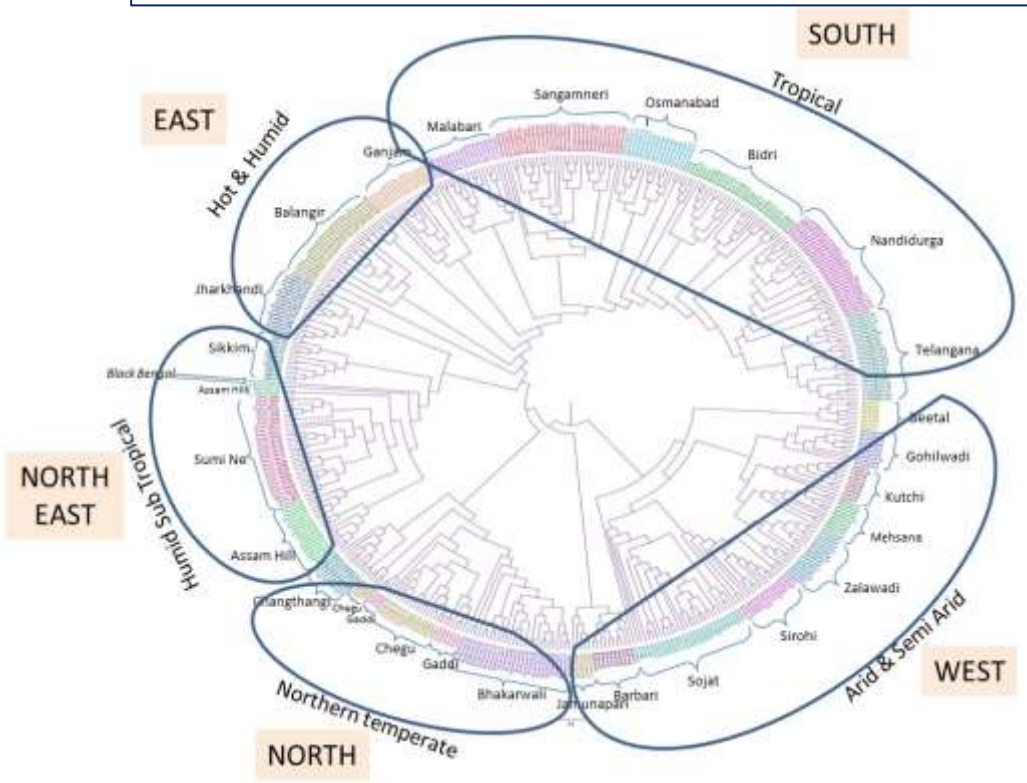
BA-Barbari
BB-Black Bengal
BE-Beetal
CH-Changthangi
CU-Chegu
GA-Gaddi
GO-Gohilwadi
GA-Ganjam
JA-Jamnapari
KU-Kuchchi
MA-Malabari
ME-Mehsana
OS-Osmanabadi
SI-Sirohi
ZA-Zalawadi

- **WGS data of 15 breeds from diverse agro-ecological regions was generated at 10X coverage using Illumina platform**
- **626,975 informative SNPs were identified.**
- **A high density SNP array for Indian goat breeds was designed using the informative SNPs.**

A patent application has been filed for the High density chip of *Capra hircus* (Application No. 202011057422; Dt. 31.12.2020)

Goat SNP Chip validation - Whole genome SNP based diversity in indigenous goat breeds

- 480 samples of 26 goat breeds/populations genotyped.
- All samples passed the SNP QC thresholds.
- Average call rate for QC passing samples was 99.831 and 96.5% markers were best recommended.



SALIENT FEATURES

- High call rate (99.831%).
- >600K markers-increased marker density.
- Genome wide coverage.

ELSEVIER

Gene

Volume 885, 15 November 2023, 147691

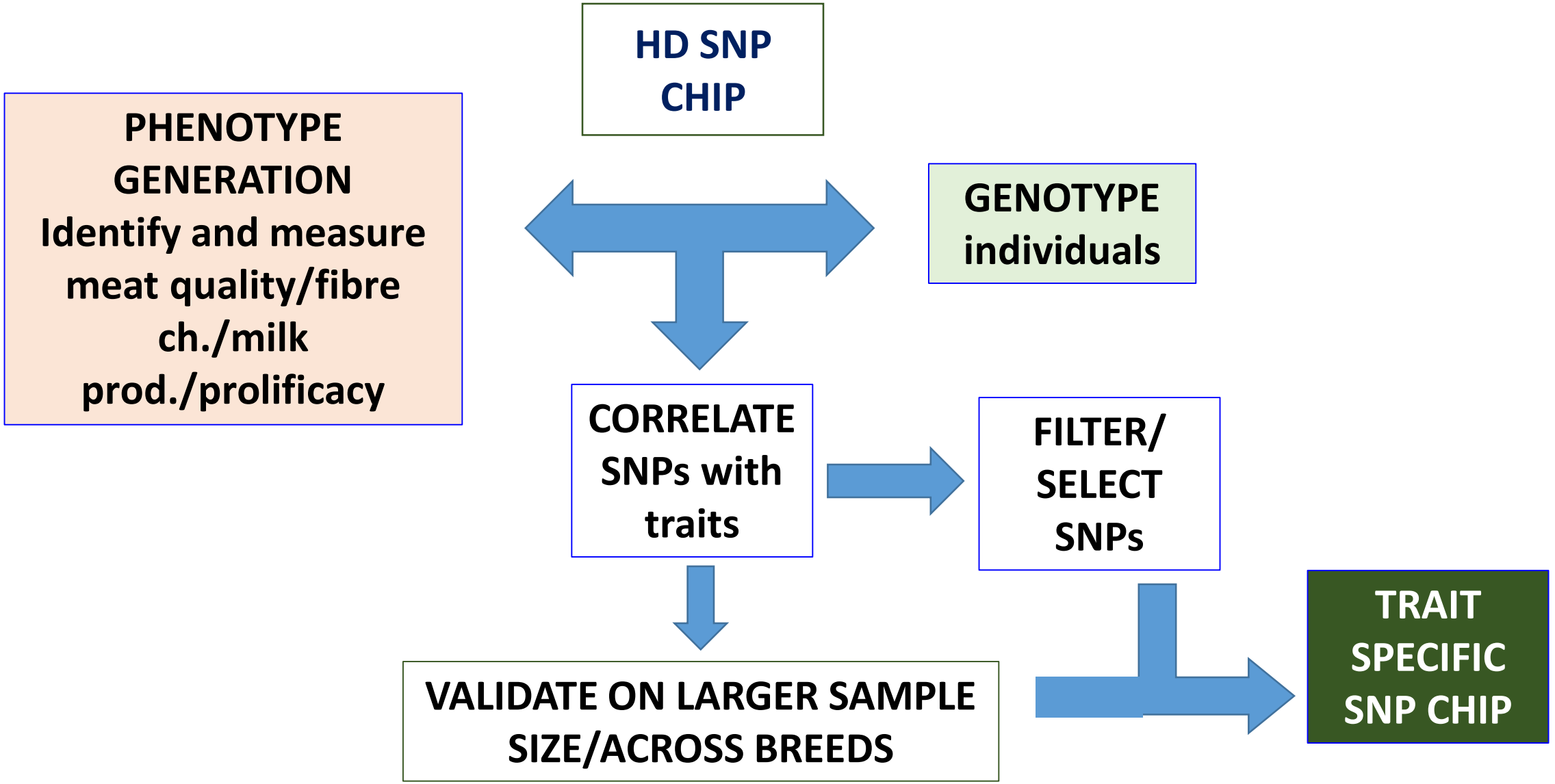
Research paper

Design and validation of high-density SNP array of goats and population stratification of Indian goat breeds

Ramesh Kumar Vijh, Upasna Sharma, Prerna Kapoor, Meenal Raheja, Reena Arora, Sonika Ahlawat, Vandana Dureja

The HD SNP chip for Indian goat can be utilized for selection and diversity analysis of indigenous goats.

TRAIT SPECIFIC SNP CHIP



Identification of genes associated with economically important traits in goat breeds of contrasting agro-ecological zones using comparative functional genomics

Barbari Goat

chevon

Pashmina Wool

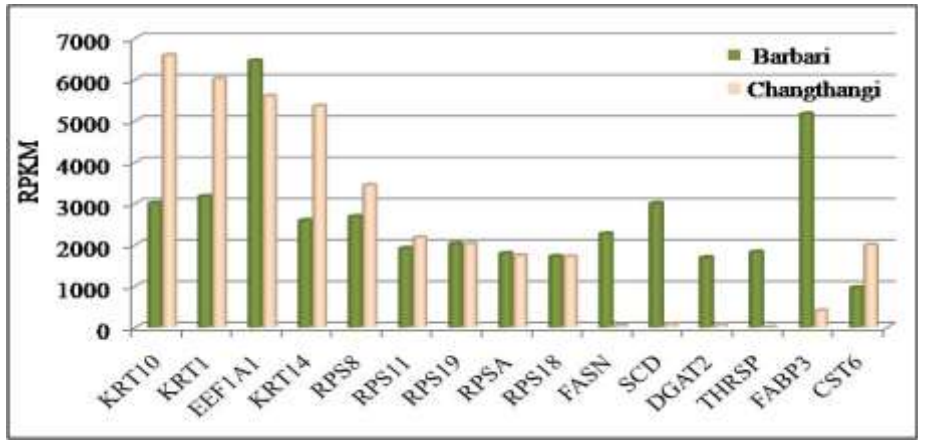
Changthangi goat

The diverse habitats, adaptation and selection strategies may have led to selection of specific traits in these breeds.

RNA Sequencing ,
4 biological replicates of LD muscles

Identification of differentially expressed genes may help in understanding the genomic basis of diversity in these breeds.

Top 15 highest expressed genes in Barbari and Changthangi goats




Genomics

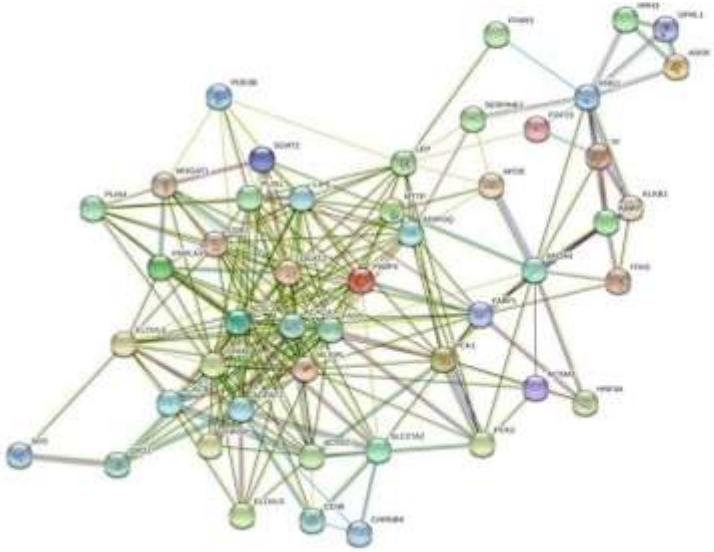
journal homepage:

Original Article

Transcriptomic diversity in *longissimus thoracis* muscles of Barbari and Changthangi goat breeds of India

Ashish Kumar, Mandeep Kaur, Sonika Ahlawat, Upasna Sharma, Manoj Kumar Singh, Karan Veer Singh, Pooja Chhabra, Ramesh Kumar Vijh, Anita Yadav, Reena Arora

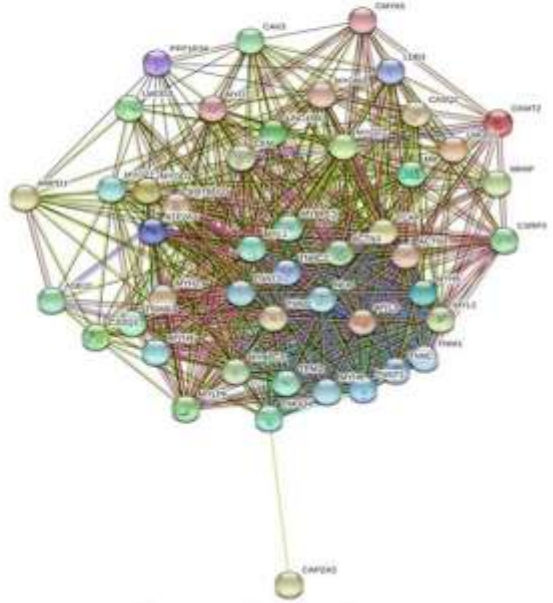
Gene-protein interaction network of highly connected differentially expressed genes in Barbari and Changthangi goats



Barbari goat

FASN, DGAT2, ACACA, LIPE, ACSL1, GPAM, MLXIPL, AGPAT2, LEP and *KNG1*

Fatty acid content, backfat thickness, meat quality



Changthangi goat

ACTN2, MYL1, TNNT3, TCAP, ACTN3, MYL3, MYOZ2, TNNI2, CAV3 and *TNNC2*

Muscle fibre type
Acclimatization to Hypoxia

Gene expression differences underscore the selection objectives of the two breeds

Pashmina fiber from Changthangi goat

Barbari goat

Changthangi goat

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SCIENTIFIC REPORTS

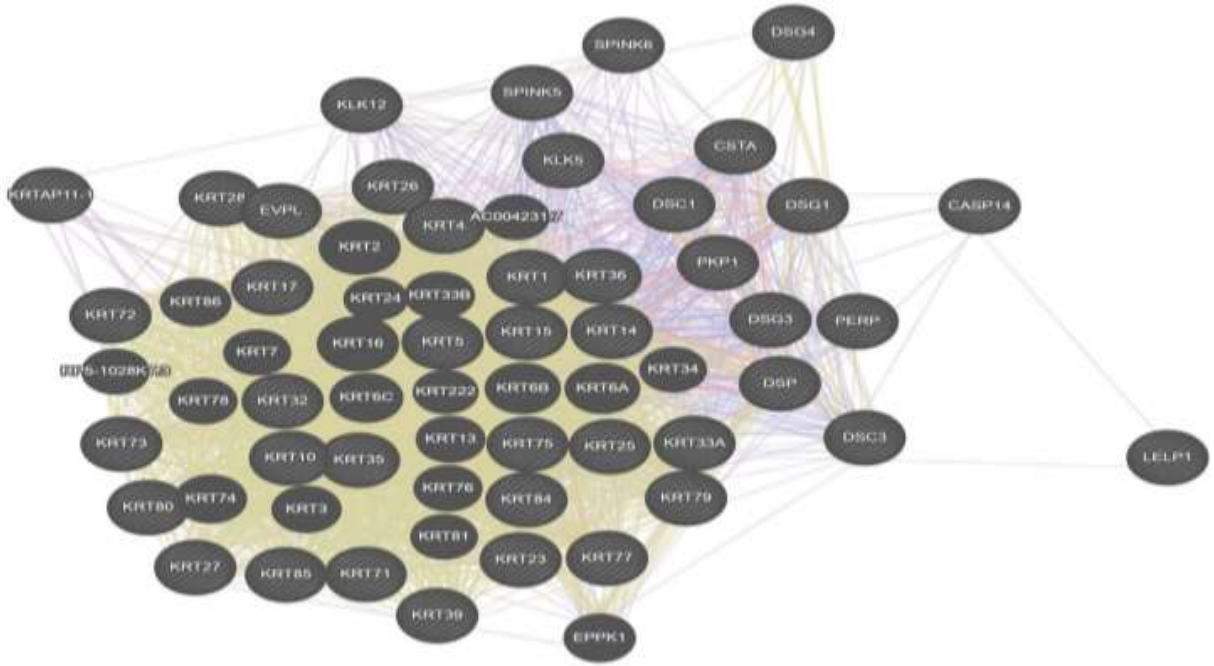
nature research

OPEN

Skin transcriptome profiling of Changthangi goats highlights the relevance of genes involved in Pashmina production

Sonika Ahlawat[1*], Reena Arora[1], Rekha Sharma[1], Upasna Sharma[1], Mandeep Kaur[1], Ashish Kumar[1], Karan Veer Singh[1], Manoj Kumar Singh[2] & Ramesh Kumar Vijh[1]

Co-expression network of DEGs involved in the keratinization pathway



- **Positive regulation of Wnt signaling pathway**
- **Negative regulation of Oncostatin M signaling pathway**

Molecular insights into Pashmina fiber production

Skin transcriptome profiles of Changthangi goats and Changthangi sheep

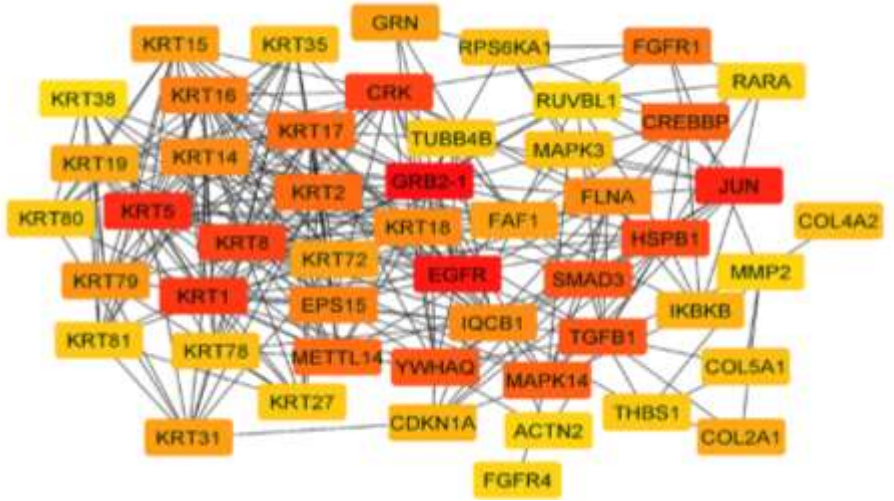
Discern the molecular drivers that underpin the recognition of Changthangi goats as the source of Pashmina

A total of 7155 genes were differentially expressed between the two species investigated in this study.

Drawing upon previously conducted studies, a collective of 225 genes correlated with fiber characteristics were extracted from the differentially expressed genes between the two species(p_{adj} of ≤ 0.05 and a Log_2 fold change of ≥ 1.5)

These genes were up-regulated in Changthangi goats as compared to Changthangi sheep.

Sub-network was constructed for the top 50 genes based on degree of interactions of up-regulated genes in Changthangi goats



Identified nodal genes of following pathways:-

MAPK *(JUN, HSPB1, TGFB1, FGFR1, FGFR4, FLNA, RPS6KA1)*

PI3K-Akt (*COL2A1, COL4A2, CDKN1A)*

Wnt *(RUVBL1)*

which are crucial for hair follicle formation and fiber characteristics.

Possible molecular determinants responsible for the superior quality of Pashmina fiber in Changthangi goats

THE PATH FORWARD…….

- Generation of well annotated genome reference assemblies for goat.
- Breed/trait specific genomic mapping-GWAS.
- Development of trait specific SNP arrays for indigenous breeds, to be used for genomic selection.
- Epigenetic modifications and gene-environment interactions to understand adaption to different environments without permanent genetic changes.

By utilizing advanced genomic tools, precision breeding programs can achieve higher productivity while preserving the rich genetic diversity unique to Indian goat breeds.

The future of Indian goat production lies not only in higher yields but also in the careful stewardship of genetic resources, ensuring the resilience and adaptability of these animals for generations to come.

THANKYOU