



Knowledge, attitude and practices towards antibiotic usage among farmers rearing yaks, dzomo and hill cattle in the high-altitude regions of Himachal Pradesh

RICHA NEGI¹ and ATUL KUMAR^{2✉}

Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh 176 062 India

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ABSTRACT

The present cross-sectional survey aimed to investigate knowledge, attitudes and practices (KAP) of farmers of high altitude regions of Himachal Pradesh towards antibiotics and their usage. The survey was carried out using pre-validated questionnaires among 162 farmers (40 males and 122 females) engaged in animal husbandry practices particularly rearing yaks, dzomo and hill cattle from Lahaul, Spiti and Kinnaur regions of Himachal Pradesh. More than 75% of the respondents were aware of antibiotics, with females (83.6%) having more knowledge in comparison to males (52.5%). Using antibiotics in lactating animals may lead to, occurrence of antibiotics or their residues in milk, question was correctly answered by 110/162 (67.91%) respondents with significant difference with respect to educational levels. It was observed that 78.68% respondents adopted the best practice of not purchasing antibiotics without prescription. Overall, it was found that farmers' perceptions of the use of antibiotics and their side effects are directly influenced by their education. Majority of the farmers were having significant knowledge regarding antibiotics, their usage and effects on consumers. They also had very positive attitude towards antibiotic usage but the practices were average in context of purchasing of antibiotics without prescription and consumption of milk from animals undergoing treatment. Therefore, education of farmers on food safety and antibiotic misuse becomes imperative for production of good quality animal origin foods.

Keywords: Animal origin foods, Antibiotics, Health risks, High altitude regions, KAP, Yaks

Antibiotics are being used for treatment of various health conditions in humans. Antibiotics have also made significant contribution to the improvement and protection of animal health and welfare. However, non-judicious or indiscriminate use of antibiotics and the inability to adhere to the specified withdrawal periods can lead to presence of antibiotic residues in animal origin foods. It has been reported that many animal origin foods like milk, meat, eggs, fish and honey, still retain traces of antibiotics from the day they were administered to the animals (Sharma *et al.* 2022). The presence of antibiotic residues in excess of the maximum residual limits can have a negative impact on the health of consumers and can lead to serious health issues such as hypersensitivity, gastrointestinal disturbances, carcinogenicity, nephropathy and transfer of antibiotic-resistant bacteria or antibiotic-resistant genes to humans (Tang *et al.* 2023, Bacanlı *et al.* 2024). In addition, antibiotic residues that exceed the legal limits can cause significant financial losses to the dairy sector as a result

of the rejection of their export consignments and losses in the fermented dairy products business as a result of the inhibition of starter fermentation during the manufacturing of cheese and yoghurt. Both of these issues can have a negative impact on the economy of small- and large-scale businesses.

Farmers of high altitude region in Himachal Pradesh are responsible for the care and management of very important genetic resources like yaks, dzomo and hill cattle (*Gauri*). Because there is a lack of knowledge on the part of farmers regarding food safety, hygienic practices and the use of antibiotics in animals, they sometime practice self-administration of antibiotics in their herds leading to prudent and non-judicious use of antibiotics (Sharma and Kumar 2023). As a result, there is a requirement to assess the levels of knowledge, attitudes and practices of farmers regarding antibiotics, their applications and impact on human health. This is important in order to get understanding on managerial practices that are linked with the use of antibiotics and to avoid residues from appearing in milk and other animal derived products.

Keeping in view the aforementioned facts, the present study was envisaged with the objective to epidemiologically investigate knowledge, attitude and practices (KAP) of farmers towards antibiotic usage and the associated factors

Present address: ¹Department of Animal Husbandry, Shimla, Himachal Pradesh. ²Department of Veterinary Public Health and Epidemiology, College of Veterinary and Animal Sciences, CSKHPKV, Palampur, Himachal Pradesh. ✉Corresponding author email: dratul9@gmail.com

concerning human health risks.

MATERIALS AND METHODS

A descriptive cross-sectional survey to explore the KAP of farmers on managemental practices with emphasis on antibiotic usage was conducted from Lahaul, Spiti and Kinnaur regions of Himachal Pradesh.

Questionnaire: The structured questionnaire containing both open and close ended questions in Hindi as well as in English was designed. The questionnaire was validated by conducting a pilot survey on 10% of final respondents. The validated questionnaire had five sections which included information pertaining to demographic characteristics of respondents, knowledge concerning the use of antibiotics, attitude towards usage of antibiotics, practices regarding antibiotic usage and other relevant data. There were ten questions in the knowledge section, four in the attitude, and six questions in the practice section.

Respondents: The sample size was estimated based on 12% response distribution, 5% margin of error and 95% confidence interval (Thrusfield 2006). A total of 162 filled questionnaires were collected from farmers (122 females and 40 males) of high altitude regions of Kinnaur, Lahaul and Spiti, i.e. geographic targeting. Sampling was done through probability sampling method using simple random sampling technique. Only those sampling units were selected randomly who were sharing one specific characteristic, i.e. they were engaged in rearing yaks, dzomo and hill cattle. The respondent's voluntary participation in the survey was confirmed in writing through an informed consent placed at the end of questionnaire. In addition, the respondents were made aware of their confidentiality and the objectives of the survey. The survey methodology employed in this study involved conducting interviews in Hindi and distributing questionnaires in person. Sufficient time was given to fill the questionnaire.

Scoring of responses: The respondents' score for knowledge, attitude and practices section was divided into three groups, i.e. good, average and poor using the $\geq 80^{\text{th}}$ percentile, $< 80^{\text{th}}$ to 50^{th} percentile, and $< 50^{\text{th}}$ percentile of the total scores, respectively using Bloom's cut-off point with slight modifications (Akalu *et al.* 2020, Feleke *et al.* 2021, Wang *et al.* 2022). In knowledge section, a score of one was assigned for each correct answer, zero for a wrong answer or for un-attempted question. A maximum score of 10 was set for knowledge based responses, with the

following criteria: good (scoring between 9 and 10), average (score between 5 and 8), and poor (score between 0 and 4). The four questions in the attitude part had a maximum score of 20. A Likert scale with a range of 1 to 5 was used to collect the replies, i.e. one for strongly disagree, two for disagree, three for do not know, four for agree, and five for strongly agree. No points were awarded for questions that were not attempted. In each item, respondents who scored four or five on the Likert scale was classified as having a good attitude; those who scored three were classified as having an average attitude; and those who scored one or two were classified as having a poor attitude. Good (score = 17-20), average (score = 10-16), and poor (score = 0-9) were the criteria for the total scoring (Taye *et al.* 2020). The maximum score for six practice-based questions was 30. On a Likert scale with a range of one to five, the responses were gathered. Non-attempted questions received a score of zero. One was for always, two was for usually, three was for sometimes, four was for occasionally, and five was for never. People who answered each item on a Likert scale between four and five were classified as having good practices, people who answered between two and three were classified as having mediocre/fair practices, and those who answered between zero and one were classified as having poor practices. The three categories for the total score were poor (score = 0-14), average (score = 15-24), and good (score 25-30) (Al-Hanawi *et al.* 2020).

Statistical analysis: Data from the questionnaires was collected for the KAP study, and it was carefully examined before being coded into excel spreadsheets. The KAP data was statistically analysed using the Independent Samples Kruskal-Wallis H-test at 5% level of significance.

RESULTS AND DISCUSSION

Socio-demographic profile of respondents: The three grouping variables of age, education level, and experience were used to categorize the respondents into variable categories (Table 1). 77.16% respondents were above 50 years of age and 22.83% were below 50 years of age. All the respondents were literate with 67.9% having qualification above 5^{th} . Only 11.7% had a qualification level above 10^{th} . Experience of respondents in animal husbandry practices were also recorded and it was found that 91.97% including 80% and 97.54% of males and females, respectively had experience less than 10 years. Whereas, only 8.02% had experience of more than 10 years. The lower animal

Table 1. Socio-demographic profile of the respondents

Grouping variable	Parameter	Total respondents (N = 162)	Male (40)	Female (122)
Age	≤ 50 years	125 (77.16%)	10 (25%)	78 (63.93%)
	> 50 years	37 (22.83%)	30 (75%)	44 (36.06%)
Educational qualification	$\leq 5^{\text{th}}$	52 (32.09%)*	21 (52.5%)	45 (36.88%)
	$5^{\text{th}} - 10^{\text{th}}$	91 (56.17%)*	16 (40%)	64 (52.45%)
	$> 10^{\text{th}}$	19 (11.72%)*	3 (7.5%)	13 (10.83%)
Experience	≤ 10 years	149 (91.97%)	32 (80%)	119 (97.54%)
	> 10 years	13 (8.02%)	8 (20%)	3 (2.45%)

*, Difference is significant at 5% level (H (1) = 36.8, $p < 0.05$; Kruskal Wallis H-test.

husbandry experience among people reflects the effect of urbanization in high altitude regions too (Thakur *et al.* 2024).

Knowledge of farmers to antibiotic use: The response of farmers to knowledge-based questions are tabulated in Table 2. More than 75% of the respondents were aware of antibiotics and among them females (83.6%) had more knowledge in comparison to males (52.5%). Kruskal-Wallis H test statistically verified the significant difference between educational qualification and the response to the question “what are antibiotics” ($H=12.12$, $p<0.05$) showing that education have impact on farmers knowledge about antibiotics. Similarly, all respondents correctly identified

the antibiotic “tetracycline” among given choices. This could be attributed to more interaction of farmers with veterinarians and para-veterinarians in the study area. A statistically significant difference between education level and the response to this question ($H=9.01$, $p<0.05$) was also observed. Due to availability of various antibiotics in the study areas, the respondent were having knowledge about the antibiotic preparations. 100% of respondents had a knowledge about the question “antibiotics are available in which form”. “When can antibiotics be used” and “what happens by using antibiotics during lactation period” were two questions asked in questionnaire and most of the respondents (70-80%) were aware of the answers. However,

Table 2. Response of farmers to knowledge-based questions

Q. no.	Test variable	Response	Males (40)	Female (122)	Overall (162)	Test statistics (H-value)*
1	What are antibiotics?	Medicines used against bacterial diseases	21 (52.5%)	102 (83.6%)	123 (75.9%)	12.12
		Tonic / health supplement	11 (27.5%)	19 (15.6%)	30 (18.5%)	
		Medicines to increase milk yield	8 (40%)	1 (0.8%)	9 (5.6%)	
2.	Which among these is antibiotic?	Melonex	0 (0%)	0 (0%)	0 (0%)	9.01
		Ibuprophen				
		Belamyl				
		Tetracycline	40 (100%)	122 (100%)	162 (100%)	
3.	Antibiotics are available in which form?	Injections	0 (0%)	0 (0%)	0 (0%)	7.09
		Capsule				
		Tablet				
		All of above	40 (100%)	122 (100%)	162 (100%)	
4.	When can antibiotics be used?	In weakness	4 (10%)	1 (0.8%)	5 (3.0%)	8.12
		To cure infectious disease	32 (80%)	120 (98%)	152 (93.8%)	
		In case of poisoning	1 (2.5%)	1 (0.8%)	2 (1.23%)	
		To increase lactation yield	3 (7.5%)	1(0.8%)	4 (2.4%)	
5.	What happens by using antibiotics during lactation period?	Taste of milk changes	4 (10%)	7 (5.7%)	9 (5.5%)	5.55
		Curdling of milk occurs	5 (12.5%)	9 (7.3%)	14 (8.6%)	
		May pose risk to consumers health	29 (72.5%)	87 (71.3%)	116 (71.6%)	
		Fall in milk yield occurs	2 (5%)	19 (15.5%)	21 (12.9%)	
6	Using antibiotics in lactating hill cattle/ yak may lead to occurrence of antibiotics or their residues in milk?	Yes	28 (70%)	98 (80.32%)	110 (67.91%)	14.78
		No	12 (30%)	24 (19.67%)	36 (22.23%)	
7.	Do you have knowledge about withdrawal period of antibiotics in milk?	Yes	21(52.5%)	102 (83.60%)	123 (75.92%)	12.78
		No	19 (47.5%)	20 (16.39%)	39 (24.07%)	
8.	What is the general withdrawal period of antibiotics in milk?	Few hours-days	17 (42.5%)	106 (86.88%)	123 (73.65%)	2.01
		Few months	10 (25%)	8 (6.55%)	18 (11.11%)	
		Few years	5 (12.5%)	8 (6.55%)	13 (8.0%)	
		All of above	8 (20%)	-	8 (4.9%)	
9.	Antibiotic misuse in animal can cause health problems in consumers of animal origin food like milk.	Yes	40 (100%)	122 (100%)	162 (100%)	1.01
		No	-	-	-	
10.	Antibiotics are sold over the counter so can be used without prescription of veterinarian?	Yes	5 (12.5%)	109 (89.34%)	114 (70.37%)	4.90
		No	35 (87.5%)	13 (10.65%)	48 (29.62%)	

*, Statistical analysis (Kruskal Wallis score) of the responses to knowledge-based questions in relation to their educational qualification.

statistically no significant difference was observed in context of educational level of the respondents. This may be due to the fact that antibiotics are used very frequently and are available over the counter without prescription. Thus, the farmers are well aware of the facts that antibiotics are used to treat animals for infections irrespective of their educational levels. Moreover, they also know that although antibiotics are used to treat animals but that may have some bad effects on human health too. This is in contrary to the observation of Nath *et al.* (2013), wherein only 42% of the surveyed livestock farmers from Uttarakhand were aware that antibiotics could cause harm, if misused.

“Using antibiotics in lactating animals may lead to occurrence of antibiotics or their residues in milk” question was correctly answered by 67.91% respondents with significant difference concerning educational levels ($H=14.78$, $p<0.05$). Respondents had some knowledge about withdrawal period and time for which residues may appear in milk but those responses were found to be statistically non-significant ($p>0.05$). Similar findings were reported from adjoining state Punjab by Kumar *et al.* (2018) in which they conducted a cross-sectional survey among beekeepers about the occurrence of antibiotic residues in honey and found out that 45.7% respondents acknowledged that their residues could appear in honey and impose public health threat.

All the respondents (100%) had given the correct answer to “antibiotic misuse in animal can cause health problems in consumers of animal origin food like milk” and response was also found to be statistically significant ($H=1.01$, $p<0.05$) showing farmers had knowledge about ill effects of antibiotic misuse. Antibiotics were usually sold over the counter without prescription in study area. This was evident in the response of the farmers too. Similar

findings have been reported by Caudell *et al.* (2017) from Tanzania and Chauhan *et al.* (2018) from India. Their studies also revealed that antibiotics were commonly used by smallholder dairy farmers and they frequently administered antibiotics to their cattle without proper veterinary consultation.

Attitude of farmers toward antibiotic use: Animal rearing is followed since ancient times and the farmers inherit the knowledge and practices from their ancestors. Thakur *et al.* (2024) also reported that people engaged in livestock rearing practices in Himalayan regions are largely enriched with native technical and health management knowledge. It is believed that the attitude of people is highly influenced by their elders in the family or in the neighbourhood and to less extent by their own educational level. Therefore, to test this hypothesis whether the attitude is knowledge driven or society driven, four questions were framed in this section. For the first attitude based question, “Do you believe antibiotics should not be used without prescription” only 1.23% responded don’t know, 14.81% responded “agree”, while 83.95% responded “strongly agree” to the question (Table 3). The results were found to be statistically significant to the level of education ($H=15.78$, $p<0.05$) as well as experience ($H=11.89$, $p<0.05$), indicating that both education and experience influence the attitude of people. All the respondents believed that dose of antibiotics varies according to age and breed of animal. The results were statistically significant to the level of education ($H=19.72$, $p<0.05$) and experience ($H=14.56$, $p<0.05$). Around 71% of the respondents had attitude to not consume milk from animals which are under treatment. 9.26% believed that milk can be consumed from animals undergoing treatment. The results were statistically significant to the level of education as well as experience. To last attitude based

Table 3. Response of farmers to attitude-based questions

Test variable	Response	Male (40)	Female (122)	Overall (162)
Do you believe antibiotics should not be used without prescription?	Strongly disagree	-	-	-
	Disagree	-	-	-
	Don't know	-	2 (1.63%)	2 (1.23%)
	Agree	12 (30%)	12 (9.83%)	24 (14.81%)
	Strongly agree	28 (70%)	108 (88.52%)	136 (83.95%)
Do you think dose of antibiotics varies according to age and breed of animal?	Strongly disagree	-	-	-
	Disagree	-	-	-
	Agree	-	-	-
	strongly agree	40 (100%)	122 (100%)	162 (100%)
As per your belief, milk from sick animals undergoing treatment should not be consumed?	Strongly disagree	-	-	-
	Disagree	-	10 (81.96%)	10 (6.12%)
	Don't know	10 (25%)	5 (4.09%)	15 (9.26%)
	Agree	5 (12.5%)	17 (10.49%)	22 (13.5%)
	Strongly agree	25 (62.5%)	90 (73.78%)	115 (70.98%)
Do you believe antibiotics used to treat humans should not be used to treat animals?	Strongly disagree	-	-	-
	Disagree	-	-	-
	Don't know	-	-	-
	Agree	-	-	-
	Strongly agree	40 (100%)	122 (100%)	162 (100%)

Table 4. Response of farmers to practice-based questions

Test variable	Response	Males (N=40)	Females (N=122)	Overall (N=162)
Do you purchase antibiotics without prescription?	Always	-	-	-
	Usually	-	-	-
	Sometimes	32 (80.0%)	30 (24.59%)	62 (38.28%)
	Occasionally	2 (5.0%)	2 (1.63%)	4 (2.46%)
	Never	6 (15%)	90 (73.77%)	96 (78.68%)
Do you stop using antibiotics in animals once symptoms of disease disappear?	Always	-	-	-
	Usually	-	-	-
	Sometimes	-	-	-
	Occasionally	-	-	-
	Never	40 (100%)	122 (100%)	162 (100%)
Do you store antibiotics for future use?	Always	-	-	-
	Usually	-	13 (10.66%)	13 (10.65%)
	Sometimes	12 (30%)	90 (73.78%)	102 (83.61%)
	Occasionally	28 (70%)	-	28 (17.28%)
	Never	-	19 (15.56%)	19 (15.58%)
Do you use antibiotics even after the expiry date?	Always	-	-	-
	Usually	-	-	-
	Sometimes	-	-	-
	Occasionally	-	-	-
	Never	40 (100%)	122 (100%)	162 (100%)
Do you share left over antibiotics with your neighbours/ relatives?	Always	-	-	-
	Usually	5 (12.50%)	-	5 (3.08%)
	Sometimes	35 (87.50%)	110 (90.16%)	145 (89.50%)
	Occasionally	-	12 (9.83%)	12 (7.40%)
	Never	-	-	-
Do you use /consume milk from animals which is under treatment with antibiotics?	Always	-	-	-
	Usually	-	-	-
	Sometimes	-	-	-
	Occasionally	-	110 (90.16%)	110 (67.91%)
	Never	40 (100%)	12 (9.83%)	52 (32.91%)

question, 100% of respondents responded “strongly agree” that antibiotics used to treat humans should not be used to treat animals. This reflects the good belief of people living in high altitude regions of Himalaya’s with regard to antibiotics usage.

Practices of nomadic pastoralists toward antibiotic use:

Practices of the farmers were highly influenced by their traditional knowledge, family practices, experience inherited from ancestors and degree of awareness. So, to assess the practices adopted by respondents, six questions were framed. It was observed that 78.68% respondents adopted the best practice of not purchasing antibiotics without prescription. However, 38.28% sometimes use to buy antibiotics without prescription (Table 4). Sankhyan *et al.* (2016) also mentioned that the veterinary facilities were usually limited to the low and middle hills thus compelling people procure antibiotics without prescription. Educational level and experience of those respondents was found to statistically influence the results. The respondents follow the directions of veterinarians for completion of antibiotic course and therefore they never discontinue that in between even after disappearance of clinical signs. People were found to never use antibiotics beyond expiry

dates. This shows education is must to ensure the proper usage of antibiotics which was reflected by Kruskal Wallis H test too ($H(4)=8.11$, $p<0.05$).

Farmers informed about the more frequent the usage of tetracycline in animal husbandry practice especially for cure of fever, respiratory infections and mastitis in high altitude regions of Himachal Pradesh. They admitted that enrofloxacin and amoxicillin are rarely used on milch animals due to their non-availability. This is in agreement with the findings of Negi *et al.* (2024), wherein application of tetracyclines’ in animals reared at high altitude regions of Himachal Pradesh was also reported. Overall, it was found that farmers’ perceptions to use antibiotics and their side effects were directly influenced by their education. Their age, experience and educational levels can be used to explain their intermediate level of understanding of the principles of antibiotics. Farmers who were older eventually had more field experience but lower educational levels, whereas farmers who were younger eventually had less field experience but better educational levels. One reason why farmers may engage in unfair practices is that they sometimes lack access to veterinary treatment because of their difficult terrain and harsh climate. Additionally,

they must be made aware of antibiotics usage in order to further improve milk quality and potentially increase its market value.

Overall scores of KAP: For every right response in knowledge section, one point was awarded and zero for every wrong response. On analysis of overall knowledge score, it was concluded that only 18.5% respondents had poor knowledge and rest 81.5% of the farmers had average to good knowledge (Supplementary Tables 1 and 2). For attitude based questions, a scoring was done out of 20. Only 22.83% had good attitude, most of the farmers (62.34%) had average attitude and very few (14.81%) were having poor attitude towards antibiotic usage. For practice based study, designing of questions was done in such a way that a response of “never” was designated as best practice with a maximum score of five for each question. Therefore, a total score of 30 was given to practice based questions. It was observed that most of the farmers (77.77%) living at high altitude regions of Himachal Pradesh followed average practices and only 4.32% of the respondents were found to follow poor practices related to antibiotic usage. The overall results of present study are in agreement with the findings of Kumar *et al.* (2018), where 50% of the farmers in Uttar Pradesh were reported to have basic understanding of the fact that antibiotic misuse could lead to resistance and adhered to recommended dosages and withdrawal periods for antibiotics showing reflecting practices.

In conclusion, the results of present survey revealed substantial variations in knowledge, attitude and practices among respondents. Majority of the farmers had significant knowledge regarding antibiotics, their usage and effects on consumers. They also had very positive attitude towards antibiotic usage but the practices were average with regards to purchasing of antibiotics without prescription and consumption of milk from animals undergoing treatment. Therefore, education of farmers on food safety and antibiotic misuse becomes imperative for production of good quality animal origin foods.

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REFERENCES

- Akalu Y, Ayelign B and Molla M D. 2020. Knowledge, attitude and practice towards COVID-19 among chronic disease patients at Addis Zemen Hospital, North-west Ethiopia. *Infection and drug resistance* **13**: 1949.
- Al-Hanawi M K, Angawi K, Alshareef N, Qattan A M N, Helmy H Z, Abudawood Y, Alqurashi M, Kattan W M, Kadasah N A, Chirwa G C and Alsharqi O. 2020. Knowledge, attitude and practice toward COVID-19 among the public in the Kingdom of Saudi Arabia: A cross-sectional study. *Frontiers in Public Health* **8**: 217.
- Bacanli M G. 2024. The two faces of antibiotics: an overview of the effects of antibiotic residues in foodstuffs. *Archives of Toxicology* **98**: 1717–25.
- Caudell M A, Quinlan M B, Subbiah M, Call D R, Roulette C J, Roulette J W, Roth A, Matthews L and Quinlan R J. 2017. Antimicrobial use and veterinary care among agro-pastoralists in Northern Tanzania. *PLOS One* **12**(1): e0170328.
- Chauhan A S, George M S, Chatterjee P, Lindahl J, Grace D and Kakkar M. 2018. The social biography of antibiotic use in smallholder dairy farms in India. *Antibiotics* **7**(2): 26.
- Feleke B T, Wale M Z and Yirsaw M T. 2021. Knowledge, attitude and preventive practice towards COVID-19 and associated factors among outpatient service visitors at Debre Markos compressive specialized hospital, north-west Ethiopia, 2020. *PLoS One* **16**(7): e0251708.
- Kumar A, Gill J P S, Bedi J S and Chhuneja P K. 2018. Health risks associated with antibiotics and pesticides in honey: Knowledge, attitude and practices of beekeepers’ in India. *Journal of Veterinary Public Health* **16**(1): 1–9.
- Kumar R, Gupta M K and Srivastava A K. 2018. Assessment of knowledge and awareness regarding antibiotic resistance among dairy farmers in Uttar Pradesh, India. *Journal of Animal Research* **8**(4): 737–44.
- Nath K, Joshi D K, Bisht P and Thapliyal D C. 2013. Knowledge and use of antibiotics among livestock farmers in Uttarakhand, India. *Veterinary World* **6**(10): 703–6.
- Negi R, Kumar A and Bhardwaj P. 2024. Unveiling antibiotic residue contamination: Assessing yak, dzomo, and hill cattle milk from Himalayan region through QuEChERS-HPLC approach and health risk assessment. *Journal of Food Science and Technology* <https://doi.org/10.1007/s13197-024-06048-3>
- Sankhyan V. 2016. Attributes of migratory goat and sheep farming and impact of some improved management strategies en-route migration in adopted flocks of Western–Himalayan region of India. *The Indian Journal of Animal Sciences* **86**(9): 1079–84.
- Sharma A and Kumar A. 2023. Multi-residue detection of antibiotics in migratory goat milk and human health risk assessment in Western Himalayan region, India. *Journal of Food Composition and Analysis* **125**: 105815.
- Sharma A, Kumar A and Sharma N. 2022. Occurrence of antibiotic residues in milk: detection and public health concerns. *Journal of Animal Feed Science and Technology* **10**(1): 23–29.
- Tang K W K, Millar B C and Moore J E. 2023. Antimicrobial resistance (AMR). *British Journal of Biomedical Science* **80**: 11387.
- Taye G M, Bose L, Beressa T B, Tefera G M, Mosisa B, Dinsa H, Birhanu A and Umata G. 2020. COVID-19 knowledge, attitudes, and prevention practices among people with hypertension and diabetes mellitus attending public health facilities in Ambo, Ethiopia. *Infection and Drug Resistance* **13**: 4203–14.
- Thakur A, Sharma A, Sharma M, Kumar A, Prasad C K, Sharma A and Vanita B. 2024. Study on organic goat production as a tool for sustainability of nomadic pastoralism in north-western Himalayan region, India. *The Indian Journal of Animal Sciences* **94**(1): 67–71.
- Thrusfield M. 2006. *Veterinary Epidemiology* (3rd edition), pp. 233. Black Well Science Ltd., London, UK.
- Wang L, Abualfoul M, Oduor H, Acharya P, Cui M, Murray A, Dominguez E and Pagadala M. 2022. A cross-sectional study of knowledge, attitude, and practice toward COVID-19 in solid organ transplant recipients at a transplant center in the United States. *Frontiers in Public Health* **10**: 880774.