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The growth potential of thermophilic *Campylobacters* on various culture media

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ABSTRACT: *Campylobacter* species represent a crucial group of zoonotic bacterial pathogens responsible for causing enteritis in various animals, including domestic, captive, wild, and non-captive animals, as well as birds. The objective of the current study was to comparatively isolate and identify *Campylobacter jejuni* and *Campylobacter coli* from faecal samples of wild animals. A total of 521 faecal samples were obtained from zoos, wildlife sanctuaries, and national parks located in the states of Uttar Pradesh, Uttarakhand, and Chhattisgarh. Following aseptic collection, processing, and primary isolation, the growth of identified *Campylobacters* was evaluated using five different artificial media, classified into two categories: blood-free and blood-containing media. The overall prevalence of *Campylobacter* spp. was found to be 11.90% (62 out of 521 samples), with *Campylobacter jejuni* accounting for 7.10% and *Campylobacter coli* for 4.80%. After enrichment, plating on Columbia Blood Agar (CBA) supplemented with selective supplements resulted in a significantly higher prevalence (11.90%) of *Campylobacter* spp. compared to other media such as Modified Charcoal Cefoperazone Deoxycholate Agar (mCCDA) (10.56%) and Sheep blood agar (BA) (8.25%). The lowest isolation rate was observed on Chocolate Agar (CA) (5.76%) and Hi-chrome *Campylobacter* agar (HCCA) (4.22%). The results of multiplex PCR confirmed the identification of *Campylobacter* species as well as the sensitivity of each culture method.

Key words: *Campylobacter*, culture media, Multiplex PCR, prevalence

Campylobacter bacteria are fastidious organisms have specific atmospheric and temperature requirements for growth, utilize menaquinones as their respiratory quinones, do not ferment or oxidize carbohydrates, and thrive in a microaerophilic environment (5% O₂, 10% CO₂, and 85% N₂) (Penner, 1988). *Campylobacter* strains causing human gastroenteritis are predominantly thermotolerant and capable of growing at temperatures as high as 42°C–43°C (Vandamme and De Ley, 1991). *Campylobacter* is a significant zoonotic foodborne bacterial pathogen that causes diarrheal diseases in both humans and animals (WHO, 2020). *Campylobacter* is one of the most prevalent bacterial agents responsible for gastroenteritis, although the true incidence of *Campylobacter*-related gastroenteritis, particularly in low- and middle-income countries (LMIC), remains poorly understood, with estimates indicating around 3 cases per 1000 population (WHO, 2012). Transmission of the pathogen to humans can occur

through various routes, including contaminated food, water, and direct contact with farm animals and pets (Elbrissi *et al.*, 2017).

MATERIALS AND METHODS

A total of 521 faecal samples from wild animals, including mammals and birds, were collected between April 2021 and March 2022 from eight zoos, national parks, and sanctuaries located in Uttarakhand (n=3), Uttar Pradesh (n=2), and Chhattisgarh (n=3), India (Table 1).

All samples were immediately processed following the guidelines of ISO 10272-1:2017(E). The samples underwent pre-enrichment in Buffered peptone water (BPW) and then enrichment was performed using Bolton broth supplemented with 5% sterile lysed defibrinated sheep blood and FD231 supplement. The enriched samples were incubated microaerobically in a CO₂ incubator at 42°C for 48

Table 1: Places of faecal samples collection and description of animals

Sl. Places of sample collection No.	No. of faecal samples collected	Ruminant	Non-Ruminant	Birds
1. Deer park and wild animal rescue center, NTD, Almora, Uttarakhand, India	24	6	18	0
2. G. B. Pant High Altitude Zoo Nainital, Uttarakhand, India	32	11	18	3
3. Jim Corbett National Park, Ramnagar, Nainital, Uttarakhand, India	138	138	0	0
4. Kanpur Zoological Park, Nawabganj Kanpur, Uttar Pradesh, India	34	10	10	14
5. Nawab Wajid Ali Shah Zoological Garden Lucknow, Uttar Pradesh, India	11	4	3	4
6. State Nandanban Zoo and Safari, New Raipur, Chhattisgarh, India	76	22	48	6
7. Periphery of Achanakmar Sanctuary, Bilaspur, Chhattisgarh, India	99	51	33	15
8. State Zoo, Bilaspur, Chhattisgarh, India	107	60	36	11
Total	521	302	166	53

hours. After the primary isolation of *Campylobacter* species, five different artificial media were assessed, categorized into two groups: blood-free media and blood-containing media.

The blood-free media included Modified Charcoal Cefoperazone Deoxycholate Agar (mCCDA) and Hi-chrome *Campylobacter* agar (HCCA). The blood-containing media consisted of Columbia blood agar (CBA), Sheep blood agar (BA), and Chocolate agar (CA). Following pre-enrichment and enrichment, the obtained isolates were inoculated onto mCCDA, HCCA, CBA, BA, and CA media and incubated in a CO₂ incubator maintained at 5% CO₂ and 42°C. Incubation was carried out for a period of 48-72 hours.

Suspected and well-isolated colonies were subcultured onto the same media for purification. Gram staining and standard biochemical tests, including oxidase test, catalase test, Hippurate hydrolysis test, *Campylobacter* nitrate reduction test, urease test, and H₂S production on TSI test methods, were performed for further identification of the presumed colonies (Atabay and Corry, 1997). Biochemically positive isolates were grown in Tryptone soya broth, aliquoted into cryo-vials with 20% sterile glycerol, and preserved at -80°C for future use.

Positive isolates, based on colony appearance and biochemical results, were further confirmed through multiplex PCR following DNA extraction (Shams *et al.*, 2017). The prevalence data of *Campylobacter* spp. recovered from each culture medium were

statistically compared using one-way analysis of variance followed by the least significant difference test. The statistical analyses were performed using SPSS version 26.

RESULTS AND DISCUSSION

The identification of suspected *Campylobacter* isolates was based on their colony characteristics, motility test, inability to grow in aerobic conditions, and Gram staining features. *Campylobacter* colonies exhibited small (1-2 mm), circular, flat to slightly raised, sticky, spreading, shiny grey-coloured colonies or water droplets on mCCDA, CBA, BA, and Chocolate agar plates. On HCCA plates, *Campylobacter* species appeared as mauve to purple-coloured colonies. The organisms appeared as pink Gram-negative rods, spiral curved rods with comma-shaped (S) or gull-wing appearance cells. Similar colony characteristics were reported by Monika (2014) and Garhia (2017).

The recovery rate of *Campylobacter* spp. in this study was higher in CBA culture media compared to mCCDA, HCA, BA, and Chocolate agar culture methods studied (Table 2). The overall prevalence of *Campylobacter* spp. was 11.90% (62 out of 521), with *Campylobacter jejuni* accounting for 7.10% and *Campylobacter coli* for 4.80%, which aligns with the findings of Acke *et al.* (2008). After enrichment, plating on CBA with selective supplement resulted in a significantly higher ($P < 0.05$) prevalence of 11.90% of *Campylobacter* spp., as also reported by Hutchinson and Bolton (1984). However, we observed a recovery rate of 10.56% on mCCDA, as

Table 2: Campylobacter spp. prevalence for each culture method and combined method (%)

Sl. No.	Culture Methods	Campylobacter species prevalence (%)
1.	mCCDA	55/521 (10.56) ^d
2.	Hi-chrome CA (HCCA)	22/521 (4.22) ^a
3.	CBA	62/521 (11.90) ^e
4.	BA	43/521 (8.25) ^c
5.	Chocolate Agar (CA)	30/521 (5.76) ^b
6.	Total	62/521 (11.90)
7.	C.D.	0.075
8.	SE (m)	0.023
9.	SE (d)	0.033
10.	C.V.	0.627

• Figures having different superscript differ significantly. (P=1.42e-12) P<0.05

reported by Corry and Atabay (1997), and 8.25% on BA (Byrne *et al.*, 2001), showing no significant differences (Table 2), followed by 5.76% on CA, as also reported by Aspinall *et al.* (1996), and 4.22% on HCCA. Multiplex PCR results confirmed the speciation of *Campylobacter* isolates as well as the sensitivity of each culture method. Considering the majority of *Campylobacter* spp. was isolated using CBA media with selective supplement, it can be concluded that this method is preferable for the isolation of *Campylobacter* spp. in this study.

It was also observed that the pre-enrichment and enrichment steps reduced transport stress and enhanced the recovery of *Campylobacter* spp. compared to direct plating or filtration onto selective media. Since CBA showed a higher recovery rate of *Campylobacter* spp. (P<0.05), it may be considered a more accurate blood-based method for assessing the actual prevalence of *Campylobacter* spp. in the sampled population. In the blood-free method, mCCDA may be relatively better for assessing the prevalence of *Campylobacter* spp. In both methods, CBA and mCCDA, hemin (Fe³⁺) and charcoal, respectively, act as a source of energy and oxygen-quenching agent, which are necessary for growth in a microaerophilic environment (Hutchinson and Bolton, 1984).

CONCLUSION

The recovery of *Campylobacter* spp. is very tedious

and time-consuming task owing to the presence of multifaceted micro-flora in faecal samples as well as fastidious and microaerophilic nature of *Campylobacter* spp. It takes 3-5 day in confirmation of a faecal sample. For isolation of *Campylobacter* species from faecal samples of wild animals pre-enrichment in PBW and enrichment in Bolton broth as well as CBA selective media were found very suitable method for accurate prevalence assessment. In India, majority outbreaks of foodborne disease go unreported, unrecognized or un-investigated and may only be noticed after major health or economic damage has occurred. In such a condition controlling the outbreaks, detection and removal of implicated foods, identification of the factors that contribute to the contamination, growth, survival and dissemination of the suspected agent, prevention of future outbreaks and strengthening of food safety policies and programmes is not possible. Hence a regular monitoring and surveillance system like European countries in needed to combat foodborne diarrhoeal diseases.

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REFERENCES

- Acke, E., McGill, K., Golden, O., Jones, B. R., Fanning, S. and Whyte, P. (2008). A Comparison of Different Culture Methods for the Recovery of *Campylobacter* Species from Pets. *Zoonoses Public Health*, 56: 490–495.
- Aspinall, S. T., Wareing, D. R. A., Hayward, P. G. and Hutchinson, D. N. (1996). A comparison of a new *Campylobacter* selective medium (CAT) with membrane filtration for the isolation of thermophilic *Campylobacters*

- including *Campylobacter upsaliensis*.
- Atabay, H. I. and Corry, J. E. L. (1997). Comparison of the productivity of cefoperazone amphotericin teicoplanin (CAT) agar and modified charcoal cefoperazone Deoxycholate(mCCD) agar for various strains of *Campylobacter*, *Arcobacter* and *Helicobacter pullorum*. *Int. J. Food Microbiol.*, 38: 201–209.
- Byrne, C., Doherty, D., Mooney, A., Byrne, M., Woodward, D., Johnson, W., Rodgers, F. and Bourke, B. (2001). Basis of the superiority of Cefoperazone Amphotericin Teicoplanin for isolating *Campylobacter upsaliensis* from stools. *J. Clin. Microbiol.*, 39: 2713–2716.
- Corry, J.E. L. and Atabay, H. L. (1997). The isolation and prevalence of *Campylobacters* from the dairy using a variety of methods. *J. Clin. Microbiology*, 84: 733-740.
- Elbrissi, A., Sabeil, Y. A., Khalifa, K. A., Enan, K., Khair, O. M. and El Hussein, A.M. (2017). Isolation, Identification and differentiation of *Campylobacter* spp. using multiplex PCR assay from goat in Khartoum state, Sudan. *Trop Anim Health Prod.*, 49: 575-581.
- Garhia, G. (2017). Studies on Prevalence, Virulence genes and antimicrobial resistance of Thermophilic *Campylobacters* isolated from poultry farms of Kumaon region. M.V.Sc. Thesis submitted to G.B.P.U.A, and T., Pantnagar, Uttarakhand.
- Hutchinson, D. N., and Bolton, F. J. (1984). Improved blood free selective medium for the isolation of *Campylobacter jejuni* from faecal specimens. *J. Clin. Pathol.*, 37: 956–957.
- ISO 10272-1:2017(En) (2017). Microbiology of the food chain — Horizontal method for detection and enumeration of *Campylobacter* spp. pp 1-24, *J. Appl. Bacteriol.*, 80: 645–650.
- Monika, J. (2014). Isolation, Epidemiology, Molecular characterization and Antibigram of *Campylobacter* from meat. M.V.Sc. Thesis submitted to G.B.P.U.A, and T., Pantnagar, Uttarakhand.
- Penner, J.L. (1988). The Genus *Campylobacter*: A decade of progress. *Clin. Microbiol. Rev.*, 1:157–172.
- Shams, S., Ghorbanalizadgm, M., Mohmmadi. S.H. and Piccirillo, A. (2017). Evaluation of Multiplex PCR Assay for the Identification of *Campylobacter jejuni* and *Campylobacter coli*. *Infect Epidemiol Med.*, 3(1): 6-8
- Vandamme, P. and De Ley, J. (1991). Proposal of a new family of *Campylobacteraceae*. *Int. J. Syst. Bacteriol.*, 41(3): 451-455.
- World Health Organization (2012). The Global view of Campylobacteriosis: report of an expert consultation, Utrecht, Netherlands. Available from: www.who.int/iris/bitstream/handle/10665/80751/9789241564601_eng.pdf
- World Health Organization (2020). *Campylobacter*. Fact-Sheets. Available from: <https://www.who.int/news-room/fact-sheets/detail/campylobacter>.

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