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# Allelopathic Influence of Leachates of Sesame Varieties on Germination and Growth of Weeds

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## ABSTRACT

**Background:** Allelopathy is described as the interference to plant growth resulting from chemical interactions among plants and other organisms mediated through release of plant-produced bioactive secondary metabolites referred to as allelochemicals. Harnessing the allelopathic properties of field crops offers a natural means of weed control without the need for external weed control agents in the field. The naturally occurring allelochemicals could be manipulated as a viable tool to control weeds and witness environment friendly and sustainable agricultural system (Farooq *et al.*, 2020). Among the oilseed crops, sesame is an allelopathic crop, which can inhibit or stimulate other crops and suppress weeds. However, studies on the allelopathic effect of different sesame varieties are scanty.

**Methods:** The experiment was conducted at College of Agriculture, Vellayani, Kerala, during June to September 2023 to examine the allelopathic effect of leachates prepared from different sesame varieties on germination and growth of three common weeds of Kerala *viz*., *Alternanthera sessilis*, *Setaria barbata* and *Cyperus rotundus*. The experiment was designed using CRD, with six treatments and pure water as control.

**Result:** The allelopathic potential of sesame varied among the different tested varieties. All varieties showed inhibitory effect on germination and growth of the tested weeds. The leachates of varieties, GT-10 and TMV-5 showed the highest inhibitory effect on germination and growth attributes of all the three weeds. The germination percentage of *Alternanthera sessilis*, *Setaria barbata* and *Cyperus rotundus* were decreased by 83.33%, 86.67% and 90% respectively with the application of leachate of variety GT-10 compared to control. The seedling vigour index I (SVI I) and seedling vigour index II (SVI II) of *Alternanthera sessilis, Setaria barbata* and *Cyperus rotundus* treated with leachate of GT 10 were lower than control by 92.5% and 90.83% , 93.89% and 93.59% and 95.79 % and 96.73% respectively compared to control. The inhibitory effect of sesame leachates could be considered as an eco-friendly approach in weed management.

**Key words:** Allelopathy, Inhibition, Leachate, Sesame, Weeds.

## INTRODUCTION

Weeds are the predominant biological constraint that cause severe yield loss in the present day input intensive agricultural system. Weeds cause a potential yield loss of 34% globally by rapidly capturing the sparse resources like sunlight, water, nutrients and space (Gharde *et al.,* 2018). Deep root system, resistance to drought and high nutrient use efficiency have made weeds competitive with arable crops.

Lack of labour availability at the right time and escalating labour wages have made manual weeding inconspicuous (Chauhan, 2012). This has paved way for increasing reliance on chemical weed control options. Nevertheless, non-judicious and inappropriate application of herbicides have resulted in a number of side effects like herbicide resistance, harmful effects on non-target organisms and environment hazards. Henceforth, development of eco-friendly weed management practices has become imperative. Allelopathy, is a natural phenomenon that refers to the interference of plants on other plants in its surroundings through the release of allelochemicals (IAS, 2018).

The allelochemicals have the potential to act as natural herbicides and resolve the risk on soil and environment by

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the excessive application of synthetic herbicides (Farooq *et al.*, 2011). The strategic application of allelochemicals through aqueous extracts, intercropping, cover cropping or mulching, has emerged as a promising and sustainable approach for effective weed suppression and the enhancement of crop productivity. (Sathish Kumar *et al.*, 2020). Among the different field crops, sesame (*Sesamum indicum* L.) is an indigenous oilseed crop which contain a number of allelochemicals like phenolic acids, flavonoids, alkaloids, tannins and saponins (Fasola and Ogunsola, 2014). Sesame is one of the versatile oldest oil crops renowned for its high priced oil (Wei *et al.*, 2022).

Application of aqueous extracts from allelopathic crops can be employed as a viable tool for weed management (Jabran *et al.*, 2008). In China, sesame has been widely used in traditional agricultural system to prevent weeds (Qin, 2013). Whole plant extract of sesame has several allelochemicals *viz*. flavonoids, terpenoids, phenolics, cinnamic acid and its derivatives, quinines, steroid and its derivatives, hydroxyl and substituted benzoic acids, alkaloids and coumarins (Zhao *et al.*, 2022). However, studies on the allelopathic effect of different varieties of sesame are very scanty. Therefore, a study was conducted to examine the allelopathic effect of leachates prepared from different sesame varieties on the germination and seedling growth of common weeds in Kerala *viz.*, *Alternanthera sessilis*, *Setaria barbata* and *Cyperus rotundus*.

## MATERIALS AND METHODS

Good quality black seeded sesame varieties were collected and raised for the experiment. The seeds of varieties Thilak, Thilathara, Thilarani and Kayamkulam-1 were procured from Onattukara Regional Agricultural Research Station (ORARS), Kerala, seeds of GT- 3, GT -5 and PKDS-8 were collected from All India Coordinated Research Project (AICRP) on Sesame and Niger, Jabalpur, GT -10 from Agricultural Research Station (ARS), Amreli and seeds of varieties TMV- 7, TMV -5 and VRI-1 from Regional Research Station (RRS), Vridhachalam. The varieties were grown in the crop museum of College of Agriculture, Vellayani from June to August 2023. The site was located at 8°30′N latitude, 76°54′E longitude and at an altitude of 29 m above mean sea level. Fresh plant samples were collected at active growth stage (30 DAS) of the crop. The samples were thoroughly washed with water to remove the soil and dirt adhered to it. The whole plant leachate of different sesame varieties were used for the experiment.

### Preparation of leachate

Plants of all sesame varieties were chopped separately into pieces of 2 cm length. The leachates of concentration 1:5 (w/v) were prepared by soaking 50 g of each variety in 1000 mL distilled water for 72 h. After 72 h the leachates of each variety was filtered using Whatman No. 1 filter paper and used on the test weeds (Unnikrishnan *et al.*, 2022).

Separate experiment was conducted for each weed. Petri plate assay was adopted for the study. The experiments were conducted in CRD in four replications and with 7 treatments. The treatment comprised of whole plant leachates of Kayamkulam 1, Thilathara, Thilarani, Thilak, GT-10, TMV-7, TMV-5, GT-3, PKDS-8, VRI-1 and pure water as control. The concentration of the leachates used for the study was 1:5 (w/v).

### Bioassay

Three commonly seen weeds in the fields of Kerala were used for the study. Broad leaved weed, *Alternanthera sessilis* (sessile joy weed), grassy weed, *Setaria barbata* (bristly foxtail grass**)** and sedge, *Cyperus rotundus* (purple nutsedge) were used as test plants. Twenty seeds of *Alternanthera sessilis* and *Setaria barbata* and ten rhizomes of *Cyperus rotundus* were placed in petri dishes of 9 cm diameter, lined with filter paper**.** The filter paper was moistened with 5 mL leachate of each variety. Petri dish moistened using distilled water was taken as control. The experiment was replicated thrice and repeated twice for confirmation. The seeds of *Alternanthera sessilis* and *Setaria barbata* were kept for a period of 7 days and rhizomes of *Cyperus rotundus* were kept for 14 days to record the observations.

The number of seeds/rhizomes germinated, seedling shoot and root length (cm), seedling fresh and dry weight (g) were recorded. The seedling shoot length was measured from the point of emergence to the tip of shoot and the seedling root length was measured from the point of emergence to tip of the root using a scale. The samples were dried in hot air oven at 65±5°C to record the dry weight. From the above observations, the computed parameters like germination percentage, SVI I and II were worked out.

a. SVI I = Seedling length (cm) × Germination percentage
b. SVI II = Seedling dry weight (g) × Germination percentage

### Statistical analysis

The data on different parameters were statistically analysed using analysis of variance technique for CRD (Cochran and Cox, 1965). The significance was tested using f test and critical difference (CD) was calculated at five per cent probability level. The statistical analysis was done using grapes Agri 1 software (Gopinath *et al.*, 2021).

## RESULTS AND DISCUSSION

### Effect of leachates on germination, seedling growth and vigour indices of *Alternanthera sessilis*

Leachates of all the tested sesame varieties showed significant reduction in the germination and growth attributes of *Alternanthera sessilis*. The leachate of variety GT-10 showed lower germination percentage in *Alternanthera sessilis* (16.67%) and it was statistically comparable with TMV-5 (23.33%). A reduction in germination percentage to an extent of 83.33 per cent was obtained with the application of leachate of GT 10, compared to

control. Whereas, higher germination percentage was shown by the application of leachate of variety Thilak which was on par with Thilarani and Kayamkulam 1. The control treatment resulted in 100 per cent germination of *Alternanthera sessilis*.

The root length of *Alternanthera sessilis* was significantly inhibited by leachates of different sesame varieties and GT-10 (1.47 cm) exhibited shorter root length which was on par with TMV-5 (1.63 cm). Similarly, shorter seedling shoot length was observed in GT- 10 (1.10 cm) but was comparable with TMV-5 (1.20 cm). The results on plant weight also showed that lower seedling fresh and dry weight were noticed by the application of leachate of variety TMV-5 (0.22 g and 0.09 g respectively) which was on par with GT-10 leachate (0.23 and 0.11 g) (Table 1).

Similarly, whole plant leachate of GT- 10 resulted in lower SVI-I and SVI-II (43.00 and 1.81 respectively) and was statistically on par with TMV-5 (65.67 and 2.20 respectively (Fig 1 and 2). The SVI I and SVI II of seeds treated with GT 10 leachate were lower than control by 92.54% and 90.83% respectively.

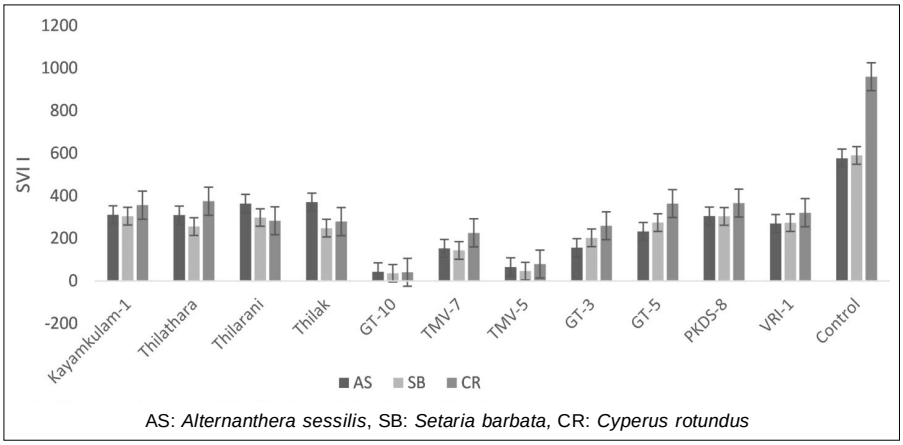
The aqueous extracts of several allelopathic crops are found beneficial to suppress many weeds in the field conditions (Irshad and Cheema, 2004). Inhibitory effects of sesame varieties might be owing to the presence of allelochemicals present in the whole plant leachates. Sesame contains several secondary metabolites, among which phenolic acids (18%), lipids (16%), flavonoids (14%), amino acid derivatives (9%) and alkaloids (5%) are the major chemical classes (Dossou *et al.*, 2021).

The phenolic compounds decrease germination by enhancing membrane damage, lipid peroxidation, electrolyte leakage and subsequent programmed cell death (Bogatek *et al.*, 2006).

Emulsion concentrate (EC) of sesame root exudate (240 µg/g) inhibited germination of broad leaved weeds *viz*., *Chenopodium album*, *Anagalis arvensis* and *Melilotus alba*, by 80, 75 and 65%, respectively over control while, EC of sesame root exudates at 280 µg/g of soil inhibited the shoot and root biomass of *Chenopodium album* by 86% and 89%, *Anagalis arvensis* by 46% and 58% and *Melilotus alba* by 42% and 72% respectively over control (Kumar and Varshney, 2007).

**Table 1:** Effect of leachate on germination percentage and seedling growth of *Alternanthera sessilis.*

| Treatments | Germination percentage | Seedling root length (cm) | Seedling shoot length (cm) | Seedling fresh weight (g) | Seedling dry weight (g) |
|---|---|---|---|---|---|
| Kayamkulam-1 | 66.67 | 2.50 | 2.17 | 0.32 | 0.16 |
| Thilathara | 60.00 | 2.80 | 2.37 | 0.33 | 0.15 |
| Thilarani | 73.33 | 2.70 | 2.27 | 0.31 | 0.14 |
| Thilak | 76.67 | 2.57 | 2.26 | 0.35 | 0.19 |
| GT-10 | 16.67 | 1.47 | 1.10 | 0.22 | 0.11 |
| TMV-7 | 36.67 | 2.30 | 2.00 | 0.29 | 0.14 |
| TMV-5 | 23.33 | 1.63 | 1.20 | 0.23 | 0.09 |
| GT-3 | 43.33 | 2.13 | 1.47 | 0.28 | 0.15 |
| GT-5 | 53.33 | 2.40 | 1.97 | 0.27 | 0.16 |
| PKDS-8 | 63.33 | 2.67 | 2.17 | 0.34 | 0.17 |
| VRI-1 | 56.67 | 2.50 | 2.22 | 0.32 | 0.17 |
| Control | 100.00 | 3.10 | 2.67 | 0.38 | 0.19 |
| LSD (p=0.05) | 10.187 | 0.253 | 0.268 | 0.038 | 0.017 |




AS: *Alternanthera sessilis*, SB: *Setaria barbata,* CR: *Cyperus rotundus*

**Fig 1:** Effect of sesame leachates on seedling vigour index I of weeds.

Allelochemicals *viz*., chlorogenic acid and iso-chlorogenic acid isolated from plant extracts of sunflower were found to possess inhibitory effect on seed germination (Anjum *et al.*, 2005). Aqueous extract of sunflower at 1:10 w/v inhibited the germination of broad leaved weed *Trianthema portulacastrum* by 56.7%, shoot length by 25 % and root length by 31.82% (Rashid *et al.*, 2020).

**Effect of leachates on germination, seedling growth and vigour indices of *Setaria barbata***

The germination of grassy weed, *Setaria barbata* was markedly influenced by whole plant leachate of different sesame varieties. Leachates of all tested varieties inhibited the germination and growth of *Setaria barbata.* Among the leachates, lower germination percentage was observed with the application of leachate of GT-10 (13.33%) and was on par with TMV-5 (16.67%). Compared to control, the germination percentage was lowered by 86.67% with the application of leachate of GT-10. The percentage inhibition of germination by leachates of other varieties were in the order; TMV 7 > GT 3 > GT 5 > VRI-1 > Thilathara > PKDS-8. While, higher germination percentage was observed with the application of leacahtes of varieties, Thilak, Thilarani and Kayamkulam 1.

Application of leachate of variety GT-10 resulted in shorter root length (1.40 cm) and was on par with leachate of variety TMV-5 (1.50 cm). The shoot length was also inhibited by leachates, among which, GT- 10 recorded the shortest shoot length (1.27 cm) which was statistically comparable with TMV-5 (1.28 cm). Application of GT-10 leachate registered lower fresh weight (0.20 g) and dry weight (0.08 g) of *Setaria* seedlings and was on par with TMV-5 (0.19 g and 0.09 g respectively) (Table 2).

Similarly, lower SVI-I in *Setaria barbata* was observed by the application of leachate of GT-10 (36.00) which was statistically on par with TMV-5 (46.33) (Fig 1 and 2). The SVI-II also exhibited the same trend and the lowest SVI-II in GT- 10 (1.05) was statistically comparable with TMV-5 (1.44). Application of GT 10 leachate lessened SVI I and SVI II to the tune of 93.89 and 93.59 % respectively, compared to control.

Unique allelochemicals in sesame like 9, 12-octadecadienoic acid (Z, Z) - methyl ester and hydroquinone inhibit the germination of seeds (Verma *et al.*, 2021).

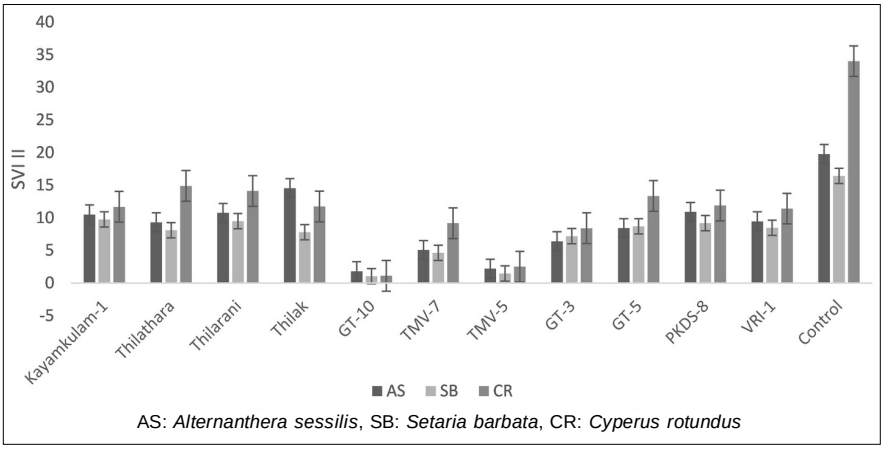



**Fig 2:** Effect of sesame leachates seedling vigour index II of weeds.

**Table 2:** Effect of leachate on germination percentage and seedling growth of *Setaria barbata.*

| Treatments | Germination percentage | Seedling root length (cm) | Seedling shoot length (cm) | Seedling fresh weight (g) | Seedling dry weight (g) |
|---|---|---|---|---|---|
| Kayamkulam-1 | 63.33 | 2.533 | 2.67 | 0.303 | 0.154 |
| Thilathara | 54.33 | 2.500 | 2.30 | 0.287 | 0.151 |
| Thilarani | 63.33 | 2.667 | 2.17 | 0.290 | 0.150 |
| Thilak | 50.67 | 2.433 | 2.20 | 0.320 | 0.146 |
| GT-10 | 13.33 | 1.400 | 1.27 | 0.203 | 0.078 |
| TMV-7 | 33.33 | 2.233 | 2.07 | 0.237 | 0.138 |
| TMV-5 | 16.67 | 1.500 | 1.28 | 0.190 | 0.090 |
| GT-3 | 50.00 | 2.333 | 1.70 | 0.263 | 0.144 |
| GT-5 | 60.00 | 2.443 | 2.03 | 0.273 | 0.144 |
| PKDS-8 | 56.67 | 2.567 | 2.23 | 0.260 | 0.146 |
| VRI-1 | 66.67 | 2.500 | 2.33 | 0.297 | 0.149 |
| Control | 100.00 | 3.100 | 2.80 | 0.347 | 0.164 |
| LSD (p=0.05) | 11.987 | 0.075 | 0.238 | 0.040 | 0.017 |

**Table 3:** Effect of leachate on germination percentage and seedling growth of *Cyperus rotundus.*

| Treatments | Germination percentage | Seedling root length (cm) | Seedling shoot length (cm) | Seedling fresh weight (g) | Seedling dry weight (g) |
|---|---|---|---|---|---|
| Kayamkulam-1 | 46.67 | 4.300 | 3.367 | 0.483 | 0.253 |
| Thilathara | 50.00 | 4.233 | 3.267 | 0.490 | 0.297 |
| Thilarani | 43.33 | 4.133 | 2.467 | 0.473 | 0.323 |
| Thilak | 40.00 | 4.453 | 2.533 | 0.483 | 0.293 |
| GT-10 | 10.00 | 2.167 | 1.867 | 0.303 | 0.111 |
| TMV-7 | 33.33 | 3.630 | 3.167 | 0.457 | 0.270 |
| TMV-5 | 16.67 | 2.667 | 2.200 | 0.383 | 0.180 |
| GT-3 | 36.67 | 3.901 | 3.100 | 0.470 | 0.227 |
| GT-5 | 50.00 | 3.97 | 3.300 | 0.486 | 0.267 |
| PKDS-8 | 46.67 | 4.50 | 3.300 | 0.453 | 0.253 |
| VRI-1 | 43.33 | 4.27 | 3.133 | 0.477 | 0.260 |
| Control | 100.00 | 5.77 | 3.833 | 0.600 | 0.340 |
| LSD (p=0.05) | 13.252 | 0.599 | 0.519 | 0.067 | 0.057 |

Aqueous extract of different plant parts of sesame (root, stem and leaf) at 100 mg/ mL delayed seed germination and reduced the shoot and root length of moso bamboo (*Phyllostachys edulis*) (Zhao *et al.*, 2022). The allelochemicals *viz.*, flavonoids, alkaloids, tannins and phenols in the leachate of sesame might have inhibited the expression and elongation of bud cells and cell division.

Root extract of soybean (46%) inhibited seed germination of *Sorghum halepense* by 50% (Mahmoodzadeh and Mahmoodzadeh, 2013). Aqueous extract of sunflower (10%) inhibited the germination of *Phalaris minor* by 85.5% (Sarvadamana *et al.,* 2019). Nadeem *et al.* (2020) reported that application of aqueous fruit extract of safflower (8%) recorded the lowest germination percentage (53.33%) of *Echinochloa crusgalli* while the shortest shoot length (5.82 cm) and root length (1.91 cm) were observed with the application of safflower leaf extract (8%).

**Effect of leachates on germination, seedling growth and vigour indices of *Cyperus rotundus***

Whole plant leachates of different sesame varieties had significant inhibitory effect on the germination and growth of *Cyperus rotundus.* Lower germination per cent in *Cyperus rotundus* was observed with the application of leachate of variety GT-10 (10.00%) and was on par with TMV-5 (16.67%). Compared to control, the application of leachate of GT-10 I reduced the germination percentage by 90 per cent.

Significant inhibition in growth parameters of *Cyperus rotundus* were also observed with the application of sesame whole plant leachates. The root length and shoot length of *Cyperus rotundus* were also inhibited with application of leachate of GT-10 (2.17 cm and 1.87 cm) which was on par with TMV 5 (2.67 cm and 2.20 cm). Similarly the fresh and dry weight of *Cyperus rotundus* were also decreased significantly with the application of leachate of variety GT-10 (0.30 g and 0.11 g respectively) (Table 3).

The same trend was observed in SVI I and SVI II. Lower values for SVI I and SVI II were observed by the application of leachate of GT 10 (40.33 and 1.11 respectively) which was statistically on par with TMV-5 (79.67 and 2.50 respectively) (Fig 1 and 2). The leachate of GT- 10 lowered SVI I and SVI II to a tune of 95.79 and 96.73 per cent compared to control.

Leaves of sesame contains specific chemicals like epigallocatechin, 3-epibartogenic acid and kaempferol derivatives that hinder the activity of α- amylase, involved in germination (Dat *et al.*, 2016). Leachate of sesame leaves (100% concentration) inhibited sprouting of *Cyperus rotundus* rhizomes by 53.33% compared to control (Hussain *et al.*, 2017).

Application of EC formulation of sesame root exudates at 240 µg/g concentration of soil decreased the shoot and root biomass of *Cyperus rotundus* by 81.30 and 91.9% respectively over control (Kumar and Varshney, 2008).

Iqbal and Cheema (2009) reported that water and methanol extracts of sunflower (50%) was effective in suppressing the shoot length and dry weight of purple nutsedge. Hussain *et al.* (2017) found that shoot length and dry weight of *Cyperus rotundus* were reduced by 53.01 and 83% respectively with the application of sesame leachate at 100% concentration compared to control. Geethika *et al.* (2022) observed a reduction in density and dry weight of *Cyperus rotundus* with the application of sunflower aqueous extract (15 L/ha).

## CONCLUSION

Sesame whole plant leachate significantly inhibited the germination and growth of weeds *viz.*, *Alternanthera sessilis, Setaria barbata* and *Cyperus rotundus*. Among the varieties, GT-10 and TMV-5exhibited the highest inhibition on germination and growth parameters. This might be due to the presence of higher concentration of allelochemicals in the varieties. The allelopathic potential of sesame could be utilized by the inclusion of sesame in the cropping system to suppress weeds. The innate

phytotoxins in the sesame varieties could be used directly as natural herbicides or might be developed in to bioherbicides in the recent future.

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### Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

### Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

### Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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