



## PHARMACOGNOSTICAL, PHARMACOLOGICAL AND TRADITIONAL PERSPECTIVES OF *APIUM GRAVEOLENS*: AN ETHNOMEDICINAL PLANT

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### ABSTRACT

*Apium graveolens* (Hindi name: Celery) belongs to family Apiaceae of order Apiales and is a biennial plant. It is about 25-250 cm in height and found in western Uttar Pradesh, north-western Haryana, Punjab, Himalayas and in some parts of Europe. Furocoumarin, coumarin and phenols are main categories of phytoconstituents present in it. Celerin, bergaten, aiumoside, aimuetin, aigravine, ostheneol, seselin are the main active phytoconstituents of active constituents. Different parts of the plant have various medicinal applications such as antibacterial activity, cardiovascular activity, antidiabetic activity, anti-depressant activity, hypolipidemic effect, effect on kidney, effects on male hormones, spermatogenesis and cytoprotective activity etc. The present review aims at the exploration of pharmacognostical, phytochemical and pharmacological studies of celery. Finally, the review concludes that this would be significantly and scientifically useful for both professional of academia and pharmaceutical industry those are doing research on this plant.

**KEYWORDS:** *Apium graveolens*, Pharmacognostical study, Phytoconstituents, Pharmacological study.



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## INTRODUCTION

Medicinal plants are used in all cultures as a source of medicine since immemorial.<sup>1</sup> India is possibly the major creator of therapeutic herbs and is correctly recognized as the “Botanical garden of the world”.<sup>2</sup> The difference between modern and old phototherapy is that now a day's the extracts of the crude drugs can be standardized to a certain content of active ingredients<sup>3</sup>. Leafy vegetables are a good source of minerals and they also possess pharmacologically activity. *Apium graveolens* (*A. graveolens*) is one of the ingredients having status of life in defensive action.<sup>4</sup> Celery is a biennial herb and is accessible in a variety of forms like celery seeds, celery flaks, celery seeds oleo resins etc. Celery therapeutic herb is a time honoured edible

vegetable. Celery was trendy in middle ages for therapeutic ailment. It has very pleasurable and distinctive odour.<sup>5</sup> 3NB (3, n-butylphthalide) is a compound uniquely found in celery which is responsible for its individual essence and odour.<sup>6</sup> The various parts (Figure 1) of the plant are used for curing diseases. Various ayurvedic text quote celery with different synonyms like Ajmod, Ajmoda and Randhunichanu, Wild celery, Badi<sup>7</sup>, Karap, Bhutghata<sup>9</sup>, Khuen.<sup>7-9</sup> Seeds of celery can work as stimulant, cardiac tonic, carminative, emmenagogue, antiseptics, bronchitis, asthma, liver disease and spleen disease.<sup>7</sup> It also possesses lithontric and alexiphatic activities.<sup>9</sup> So, the comprehensive review is made for pharmacognostical, pharmacological and traditional perspectives of *A. graveolens*.



**Figure 1**  
*Different parts of Apium graveolens (A) Seeds<sup>10</sup>, (B) Roots<sup>11</sup>, (C) Leaves<sup>12</sup>, (D) Stalk<sup>12</sup>.*

## DISCUSSION

### PHARMACOGNOSTICAL STUDY

According to Chopra RN *et al.* 2010, there are two foremost varieties of celery acknowledged. *A. graveolens* var. *dulce* (Mill) Pers core variety under cultivation in India, and another variety *rapaceum* (Mill.) Gaundich (called celeriac).<sup>13-14</sup> Celery fruit suggests itself as separated mericarp, the cremocarp is brown, roundish-ovoid, innovatively dense and about 1.5 mm lengthy, 1.5 mm. broad and 0.5 mm thick. Each mericarp has scarcely prominent primary ridges, and usually six to nine or occasionally twelve vitae, two being on the commissural surface and three in each vallecula. The seed is orthospermous.<sup>15</sup> Taste and color is somewhat like anise, but later taste becomes bitter, and the color become bit faint in evaluation with

anise.<sup>16</sup> Transverse section is almost pentagonal in shape.<sup>17</sup> The microscopic character also include polyhedral epidermal cells with slightly wavy anticlinal walls. Outer walls are completely striated and habitually papillose. Endocarp tissue is narrow, thin walled, lignified and agilely arranged. Endosperm is impenetrable, made up of thick-walled polyhedral cells, having aleurone grains, rosette crystals of calcium oxalate and fixed oil.<sup>10</sup>

### Habitat & Distribution

Celery is native to Europe<sup>18</sup>, and in Europe imported and cultivated chiefly from the southern Europe.<sup>15</sup> It is cultivated in France,<sup>10</sup> also found in Italy and in Italy it extends in Sweden, Egypt, Algeria and Ethiopia. Celery is also found in Asia.<sup>5</sup> In India it is cultivated in western Uttar Pradesh and north-western Haryana, Punjab, Himalayas.<sup>5,17</sup>

**Taxonomical Classification<sup>5</sup>**

Kingdom	Plantae
Subkingdom	Tracheobionta
Super-Division	Spermatophyta
Division	Mangoliophyta
Sub-division	Angiospermae
Class	Mangoliopsida
Order	Apiales
Genus	<i>Apium</i>
Species	<i>Graveolens</i>

**Classification**

Synonym: *Apium petroselinum* Linn.<sup>12</sup>

Based on cultivation, celery can be classified as-

- a) *Apium graveolens*
- b) *Apium secalinum*
- c) *Apium smallege*
- d) *Apium rapaceum*<sup>5</sup>

**PHYTOCHEMICAL CONSTITUENTS**

Moisture content of celery leaves and stalks is 80.30 to 93.5% whereas moisture present in seeds is 5-11%. Protein percentage is almost equal in seeds and leaves with stalks i.e. 0.8%. Total ash content in case of seeds is around 6.9-11.0% and in acid insoluble ash it is 0.5-4.0%. Vitamin A, B and C are also reported to be present in celery leaves.<sup>5,19-20</sup> In wild type of celery roots, stems, leaves and seeds contain crude fiber as 10.25%, 17%, 84%, 19.28% and 7.37% respectively.<sup>21</sup> A study on three continuous harvest of wild celery's suggest that the first harvest, 2<sup>nd</sup> harvest and 3<sup>rd</sup> harvest have essential oil contents as 2.28%, 2.10% and 2.44% respectively in the first season while in the 2<sup>nd</sup> season the percentage is 2.22%, 2.11% and 2.28% which clearly indicates that there is a decline in the essential oil contents in the second crop.<sup>22-23</sup> Celery also have phenol and furocoumarin compounds in which Furocoumarin is the main phytoconstituent that have celerin, celeroside, apiumoside, bergapten, epiumetin, apigravrin, ostheno, isopimpinelin and isoimperstorin. Phenols include apiiin, apigenin and graveoside A and B.<sup>23</sup> Limonene is the chief product of steam distillation of celery. The study reveals that it also contains p-dimethyl styrene, N-pertyl benzene, caryophyllene,  $\alpha$ -selinine, N-butyl pthalide, sedanenolide sablene,  $\beta$ -elemene, trans-1 2 epoxy limonene and thymol<sup>5</sup>. Fixed oil, protein and mucilage are also present in celery's fruit.<sup>15</sup> It also contains coumarin seselin and apigravrin, new furanocoumarin glucd, apimucoside, dehydrofurocoumarin glucd and 2-

dihydrofurocoumarins. Seeds husk contains graveobioside A and B, fatty acids, 7-octadecenoic acid, and seeds itself possess stigmasterol, bore-pheromone steroid etc. Essential oil constituents of root are buphthalide and neocnidillide.<sup>24</sup> Literature survey also reports that volatile oil consists of d-limonene-60, d-seline 10, sedanonic acid and its anhydride 0.5% and sedanolide 2.5-3%.<sup>13,14</sup> It is said to contain sulphur., It also contains apoil-A poisonous principle, a lucoside apiin, albumer, mucilage and salt.<sup>9</sup> Besides four furocoumarins viz isopimpinaline, Apiumetin ( $C_{14}H_{12}O_4$ , M.P.198 °C) and rutaretin ( $C_{14}H_{14}O_5$ , M.P.1980°C) substances called are isoimperatorein. Apigravrin, graveobioside B, umbelliferone, 8-hydroxy-5-methoxysoralen, myristic acid,  $\Delta^{6,7}$ -octadecanoic acid,  $\Delta^{7,8}$  octadecanoic acid. Unknown alkaloids thus possessing tranquilizing and anticonvulsant activities have also been isolated. Other constituents present are 3-n-butylhexahydrophthalide, 3-n-butyl-4,5-dihydrophthalide, 3-isovalideneephthalide, 3-n-butyl-4,5-dihydrophthalide,  $\alpha$  and  $\beta$  -eudesmol besides some minor constituents.<sup>18</sup> Elemental composition of the seeds is as followed N 1.78, P 0.33, K 1.38, Ca 1.65, Mg 0.50, S 1.15 percent and Fe 878, Mn 138, Zn 76, Cu 14 parts per million (ppm) and As 0.38 mg/g. The fatty oil obtained from the seeds contains hydrocarbons 1.5, wax esters, sterol esters 1.0, triglycerides 72.3, diglycerides 6.5, monoglycerides 6.5, free fatty acids 5.5, and glucoside 1.5%. The (+)- 2,3-dihydro-9-hydroxy-2[1-(6-sinapinoyl)- $\beta$ -D-glucosyloxy-1-methylethyl-2--7H-furo [3,2 g][1]-

benzopyran-7-one, furanocoumarins glucoside and 5-methoxy-8-o- $\beta$ -D-Glucosyloxyxpsoralen have been isolated from the seeds. Steam distillate of steam distillation provide limonene, selinine, butylphthalide, ligustilide and  $\alpha$  selinene. However, the major constituents from a libyan sample are apiole, sedanolide and 3-butylphthalide. These compounds are known to possess strong characteristics celery aroma. The furocoumarins oxypeucedanin is also found in the plant extract.<sup>25</sup> The odoriferous C<sub>11</sub> hydrocarbons 1-(E,Z,Z)-3,5,8-undecatetraene and 1-(E,Z)-3,5 undecatriene have

been isolated from the edible peeled root. These compounds are reported to manipulate the usual odour characteristics of the plant even at a very low concentration. The roots also contain erudilide, ligustilide and senkyunolide. The compounds celeroin, vallein and nodakenin have been isolated from the seeds. The other constituents present in essential oil are n-pentyleyclohexadiene 0.9%, n-pentylbenzene 1.7%,  $\beta$  elemene+caryophyllene 0.5%,  $\alpha$ -terpineol 0.7%,  $\beta$ -pinene 0.5% and myrcene 1.2% (Table 1,2).<sup>26</sup>

**Table 1**  
**Nutritional value per 100 g of raw Celery.<sup>27</sup>**

Energy	Carbohydrates (2.97 g) (Including fiber)		Fat	Protein	Vitamins (%)								
	Sugars	Dietary Fiber			A	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>6</sub>	B <sub>9</sub>	C	E	K
50KJ	1. 4 g	1.83 g	0.17g	0.69 g	3	2	5	2	6	9	4	2	28

**Table 2**  
**Trace metals per 100 g of raw Celery.<sup>27</sup>**

Trace Metals (%)	Ca	Fe	Mg	P	K	Na	Zn	Water
4	2	3	3	6	5	1	95	

*Ca- Calcium, Fe- Iron, Mg- Magnesium, P-Potassium, Na- Sodium, Zn- Zinc*

## TRADITIONAL USES

In general celery is used as a vegetable, the volatile oil which is obtained from its seeds are used in

perfumery and pharmaceutical industries.<sup>27</sup> Some traditional formulations, traditional medicinal uses of *A. graveolens* are shown in Table 3,4.

**Table 3**  
**Traditional medicinal uses with traditional formulations of *A. graveolens*.**

Traditional Medicinal Uses	Traditional Formulations	References
Alterative diuretics	Celery coffee from celery root	Nandkarni et al. <sup>9</sup>
Strength to brain and nerve	Take celery 2 parts, <i>Cyperus rotundus</i> 0.5 parts, Anise seed 11.5 parts and <i>Valerian wallichii</i> 1 part. Mix and reduce them to powder	Nandkarni et al. <sup>9</sup>
Colic pain, Flatulence	Celery 2 parts, Anise seeds 1 parts and sugar 1 part	Nandkarni et al. <sup>9</sup>
Flatulent colic and used as an adjunct to antispasmodic and carminative medicines	Wild celery 1 part, <i>Ptychosperma aijowan</i> 1 part and water 20 parts. Distilled the whole.	Nandkarni et al. <sup>9</sup>
Chronic illness	Organic carrot juice and celery juice	Fazal <sup>24</sup>
Suppressed testicular function	Ingestion of herb	Chopra et al. <sup>13,14</sup>

**Table 4**  
**Phytochemical constituents and traditional uses of various parts of *A. graveolens*.**

Source	Phytochemicals	Traditional Use	Reference
Fruit	Volatile oil, protein and mucilage	Sedative, tonic and use in rheumatism	Wallis et al. <sup>15</sup>
Seeds	Essential oil and oleoresin	CNS depressant, Tranquillizing activity	Chopra et al. <sup>13,14</sup>
Roots	Erudulide and senkyunolide <sup>30</sup>	Diuretics, anascara and colic <sup>7</sup>	Chopra et al. <sup>13,14</sup>
Essential Oil	d-limonene, 3, n- buphthalide, <sup>31</sup> Terpenes, sedanolic acid Coumarins, furanocoumarin glycoside <sup>17</sup>	Mild depressant activiy <sup>13</sup>	Chopra et al. <sup>14</sup>
Whole plant	Apiin, Sulphur, mucilage and salts <sup>23</sup>	Diuretics, emmenagogue, lithontropics and alexipharmac <sup>9</sup>	Nandkarni et al. <sup>9</sup>

## MEDICINAL VALUES

It was found that celery reduces the level of uric acid, so it is used as a remedy for kidney problems. Celery seeds are mainly used for reducing the degenerating body joints. It is used mainly for arthritis, rheumatism and hyperuricemia and in gout<sup>12,5</sup>. The seeds and stalks are utilized as spasmolytic, carminative, anti-inflammatory, anti-rheumatics, sedative, hypotensive and urinary antiseptics agent. Celery is also used as aphrodisiac, anthelmintics, antispasmodic, carminative, diuretics, emmenagogue, laxative, sedative, stimulant and toxic. It is used in the relief of griping pains and flatulence. Celery can be used in the treatment of bright's syndrome, post-nasal edema, nuisance and in insomnia. Carrot juice with celery is packed with minerals and is known to be helpful in the treatment of various chronic illnesses. Celery seed is used in tackling of chemical imbalance of body and in the treatment of gastric disorders.<sup>5</sup>

## PHARMACOLOGICAL APPLICATIONS OF *APIUM GRAVEOLENS*

*A. graveolens* have various pharmacological application as listed in below and in Table 5.

### *Antidepressant activity*

Tail suspension and forced swim models (FSM) were chosen to investigate antidepressant action of methanolic extract of seeds. Both tests defined a dose based, fall in time of stillness that was as good as imipramine (20mg/kg). Surprisingly, the effect of 200 mg/kg of extract was superior to 20mg/kg imipramine. A dose of 100mg/kg was also found to be noteworthy in comparison to vehicle treated group. These experiments confirmed that the methanolic extract of *A. graveolens* seeds have dose reliant antidepressant activity in animal models.<sup>19</sup> (mechanism)

### *Antibacterial activity*

Liquid CO<sub>2</sub> extracts of dried roots and leaves of celery were set in pilot plant scale equipment by using diverse operation cycle program. Ethanolic solution of extract was used and the scheme used for antimicrobial activity was agar diffusion method. The test was performed on various micro-organisms including *Staphylococcus aureus*, *Listeria monocytogenes*, *Escherichia coli*, *Citrobacter freundii*, *Salmonella typhimurium*, *Bacillus cereus*, *Hafnia alvei*, *Proteus vulgaris* *Enterococcus faecalis* and *Enterobacter aerogenes*. Leaf extract was found to be more efficient and effective than root extract and the elevated dose was found to be more useful. *P. vulgaris* and *C. freundii* were aggressive of celery extracts.<sup>28</sup>

### *Cardiovascular activity*

The contraction in atria of rats and the mean blood pressure of anaesthetized rabbits was measured after delivery of aqueous and ethanol extract of *A. graveolens*. The study reveals that ethanol extract produced more significant hypotensive effect when compared to aqueous extract. Hypotensive effects of the extracts could be appreciably blocked by delivering atropine (0.3mg/kg).<sup>29</sup>

### *Hypolipidemic effect*

Male albino rats were used to investigate the hypolipidemic effect of ethanolic extract of celery. Doses (213 and 425mg/kg) were administered orally for sixty uninterrupted days. Triglycerides (TGs), total serum cholesterol and LDL decreased, and level of HDL increased in treated rats. This result confirms the significant and right use of celery for hypolipidemic effect from the ancient times. The possible mechanism may be rising energy disbursement, inhibition of the hunger, prevention of absorption of nutrients from the GIT and decrease of energy intake from food.<sup>26,30</sup>

### **Cytoprotective activity**

Sedanolide is one of the main ingredients of celery oil. Celery has been used in the treatment of gout and rheumatism on the basis of  $H_2O_2$  and tBOOH is used in *in-vitro* for production of toxicity. Highly differentiated cells of human hepatoma and colon adenocarcinoma cells were used for checking of cytoprotective activity. Cells survival was measured with the help of spectrophotometer. The percentage of viable cells was assessed by MTT assay. The viability of intestine cells was more when compared to liver cells which can lead to the conclusion that high concentration of sedanolide has some toxic effect on liver cells although sedanolide did not show any protection.<sup>31</sup>

### **Effects on male hormones**

Hydroalcoholic extract of leaves of celery was used at the dose of 200 and 300 mg/kg on male rats. Blood was taken from their heart. Serum level of testosterone, LH and FSH was studied. LH and FSH was measured using immunoassay method. The level of LH was found to decrease significantly. But there is no fall in the level of testosterone and FSH. The learning accomplished that extract does not have any substantial side effect on the emission of hormones in male rats.<sup>5</sup>

### **Nephrotoxicity study**

The extract of celery leaves was studied for nephrotoxicity induced by gentamycin 200, 400 and 600 mg/kg. Lipid peroxidation, antioxidant enzyme activity and histopathology were done on both the kidney. The results of biochemical analysis showed significant decrease in serum urea nitrogen, uric

acid and creatinine in comparison to gentamycin intoxicated rats.<sup>32</sup>

### **Spermatogenesis study**

Hydroalcoholic extract of celery leaves 100 and 200 mg/kg was studied for spermatogenesis and investigated the epidymal sperm count and histopathology. Celery was found to affect the pituitary gland and increase sex hormones and the number of cells of testis can be possible mechanism<sup>4</sup>. Celery was also known to have anthelmintic effect if administered 1.2 to 4.0 g daily dosage of the seeds and 23 g or 15 ml 3 times daily juice of the fresh plant.<sup>33</sup> Celery fruit (seed) extracts are broadly employed as a flavoring agent in many food products, such as candies, frozen dairy desserts, baked goods, meat products, soups, puddings, gelatins, alcoholic and non-alcoholic beverages, condiments and relishes, snack foods, and others.<sup>34</sup> The seeds are bitter and have burning sensation.<sup>35</sup> It has been used as an appetite and libido stimulant in traditional medicine.<sup>36, 37</sup>

### **Antidiabetic study**

The potent of n-butanol (n-BtOH) extract of seeds of *A. graveolens* was studied in streptozotocin-induced diabetic male rat model in ameliorating the lipid peroxidation and antioxidant status. n-BtOH extract of celery seed at a dose of 60 mg/kg body weight in male rats or insulin treatment maintained the normal level of blood glucose, increased gain in body weight, regulated the activities of all antioxidant enzymes and significantly ameliorated stressful complications accompanied by diabetes mellitus.<sup>34, 38</sup>

**Table 5**  
**Pharmacological applications of *A. graveolens***

S. No.	Pharmacological Activity	Animal/ Micro-organisms	Part	Extract	Dose	Model	Mechanism
1.	Antibacterial activity	<i>Salmonella typhimurium</i> <i>Hafnia alvei</i> <i>Citrobacter freundii</i> <i>Listeria monocytogenes</i> <i>Escherichia coli</i> <i>Bacillus cereus</i> <i>Staphylococcus aureus</i> <i>Enterobacter aerogenes</i> <i>Proteus vulgaris</i> <i>Enterococcus faecalis</i>	Roots (Less Effective)	Ethanolic	1, 5 and 10 % <sup>w/v</sup>	Agar diffusion Method <sup>24</sup>	Myrcene and some sesquiterpenes characteristic phytoconstituents of leaf extracts are more active against all micro-organism in comparison to carvone of root extract. <sup>28</sup>
2.	Cardiovascular Activity	Rabbit	Aerial Part	Aqueous (Least hypotensive)	0.5-15 mg/Kg, i.v.	Blood pressure of anaesthetized rabbits	Experiments shows presence of cholinergic components in hypotensive and cardio-inhibitory activity of A. graveolens. <sup>29</sup>
3.	Antidepressant Activity <sup>18</sup>	Swiss Albino Mice	Seeds	Ethanolic (Most hypotensive)	0.02-0.75 mg/ml, i.v.	Contractility of isolated atria of the rats	
4.	Hypolipidemic effect	Male Rat	Seeds	Methanolic Extract	100 mg/Kg & 200 mg/Kg, Oral	Forced swim Test Tail Suspension Method	Imipramine like mechanisms <sup>19</sup>
5.	Cytoprotective effect	HepG2 and CaCo-2 cells line	Seeds	Methanolic Extract	425 mg/kg & 213 mg/kg, Oral	Blood Test (Cholesterol profile)	Piquancy of the mobilization, inhibition of lipoproteins lipase activity, enhancing energy expenditure, prevention of absorption of nutrients from the GI tract result in reduction of the appetite, and decreasing food intake. <sup>26,30</sup>
6.	Effect on male hormones	Rats	Leaves	Hydroalcoholic Extract	7-500 $\mu$ M for 24 h	Comet assay	Fragmentation of DNA strands was significantly observed in HepG2 in contrast to CaCo-2 cells after 24 h incubation <sup>31</sup>
					200 mg/kg & 300 mg/kg, Oral	Blood test (Testosterone, FSH & LH)	Decrease LH value. No effect on testosterone and FSH <sup>5</sup>

7.	Nephrotoxicity study	Rats	Leaves	Ethanolic extract	200 mg/kg 400 mg/kg, 600 mg/kg Oral	Blood test serum urea nitrogen, uric acid and creatinine	Protective role of flavonoids extracts from celery may cause minimization of oxidative stress induced by dichloroov in rats. Antioxidant effect may further contribute to protective effect of kidney. <sup>32</sup>
8.	Spermatogenesis	Rats	Leaves	Hydroalcoholic extract	100 mg/Kg & 200 mg/Kg, Oral	Epididymal sperm count Histological studies	Affect the pituitary gland and increase sex hormones and Increase in no of cells of testis can be possible mechanism <sup>33-36</sup>
9.	Antidiabetic	Male Rats	Seed	Butanolic extract	60 mg/kg body weight in male rats, Oral	Streptozotocin-induced diabetic male rats	n-BtOH extract of celery seed or insulin treatment maintained the normal level of blood glucose, increased gain in body weight, regulate the activities of all antioxidant enzymes and significantly ameliorating stressful complications accompanied by diabetes mellitus. <sup>34</sup>

## CONCLUSION

From pharmacognostical, phytochemical and pharmacological literature, we conclude that celery is a highly potential medicinal plant that is being used traditionally for a long time. The current review is a comprehensive literature survey that emphasize on pharmacognostical, pharmacological and various health benefit that can be obtained from the plant. Literature survey also shows that it contains various phytoconstituents like celerin, bergapten, aiumoside, aimuetin, aigravine, ostheneol and seselin. Because of these constituents, *A. graveolens* is found to possess antibacterial activity, cardiovascular activity, anti-depressant activity, antidepressant activity, hypolipidemic effect and cytoprotective activity. A number of researches is still required to validate the effectiveness of drug in the treatment of various disorders. Finally, this review will be scientifically useful to both the professionals of academia and pharmaceutical

industry and to those that are doing research on this plant.

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## AUTHORS CONTRIBUTION STATEMENT

Dr. Jitendra Gupta conceptualized, gathered and analyzed these data with regard to this work. Dr. Reena Gupta and Mrs. Kanchan Mathura gave necessary inputs were given towards the designing of the manuscript. All authors discussed the results and contributed to the final manuscript.

## CONFLICT OF INTEREST

Conflict of interest declared none.

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