

Variation in *Acacia senegal* Seed size and Germination Collected from Different Regions of Rajasthan

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ABSTRACT

Acacia senegal is common in Rajasthan and its seeds are used in Panchkutta vegetable. It is good for fencing and also on bunds fencing. Seeds from different locations were collected and their seed size and other parameters were studied. Its germination in laboratory with different treatments as well as with different concentrations of Growth regulators was studied. Results shows that seed size varies with different locations even in same districts also. However there is no correlation with germination behavior. Phenological study and reproductive biology of seeds need to be studied in details.

Keywords: Seed germination; Growth regulators; Reproductive biology; Phonology.

1. Introduction

Acacia senegal (L) wild is a deciduous shrub with branches that typically emerge from the ground with height of 5-15 meters with trunk of 30 centimeters. Tree bark is grayish-white but aged trees bark become grey, pointed and strong hooked thorns of 3-5 mm in length present at the nodes of the branches. Leaves have double compound up to 2.5 cm long with 3-8 pinnate. The flowering seasons starts from late December to Mid of March. Flowers are normally white to yellowish in colour. After that fruiting starts from late February to end of April. The pods are light brown in colour. Pods are light in weight, straight or slightly curved in shape with 7.5 to 18 cm long and approx 2.5 cm wide. Each pods carries 1-8 seeds, these seeds are round and flats, 8-12 mm long and seeds are olive brown in colour. It is commonly called as Gum Arabic tree, Kumat, Kumatiyo and Khair. It is native to arid and semi-arid region of Africa and Asia. The plant tolerates a pH range of 5-8 and does well in both sandy and dark loamy soil. It endures annual precipitation ranging from 200 mm to 800 mm. *Acacia senegal* is heat-tolerant yet susceptible to frost (El-fadi, 1997). *Acacia senegal* provides high-quality gum, which is utilized in the ink, paper, cosmetics, food, and pharmaceutical sectors. The mineralization of leaf litter increases the fertility of sandy soil and effectively reduces erosion (ICRAF, 1992). According to Bello and Ambursa (2006), the blooms are loved by bees, and the bark, leaves, and gums are used to cure gastritis, bleeding, eye infections, colds, and diarrhea.

It is abundantly dispersed throughout the dry savannas of tropical Africa and reaches the Red Sea and India. The hot, dry summers, sub-humid monsoon, and cold, dry winters are common characteristics of the climate of the western Rajasthan desert habitat in which *Acacia senegal* is found. *Acacia senegal* is a tall, spiky tree that reaches a height of five to six meters. Its conspicuous spikes of creamy white blooms range in length from five to ten centimeters. In locations with yearly rainfall as little as 100-150 mm, *Acacia senegal* can thrive (Okoro 2002 and Omer, 1989). It is a multifunctional tree with nitrogen-fixing active root nodules, which are known ecologically to increase soil fertility (Anthony and Young, 1990). Moreover, it enhances the preservation of soil moisture, lowers erosion, and reduces desertification. However, seed dormancy hinders the growth of this significant tree.

The failure of viable seeds to germinate under favorable circumstances is known as dormancy. There are several kinds of seed dormancy, including morphological, chemical, mechanical, and physical dormancy. According to **Odo and Oleghe (1988)**, changes in the environment might impact seed germination and growth. Researchers have employed a variety of techniques to end seed dormancy. Cold water, boiling water, and sulfuric acid are some of these techniques (**FAO, 2008 and Doran et al., 1983**). The reason behind conducting this study was to investigate the effects of pretreatment on seed germination of *Acacia senegal* from different location of Rajasthan (India).

2. Review of Literature

The most significant dryland resources of the desert environment in western Rajasthan are the dry land tree species, known as *Acacia senegal*. The climatic conditions in the western Rajasthan limited the built-up of soil organic matter and soils are usually lacking in nitrogen. The studies have been carried out and shows the breaking the seed dormancy of the seeds required 15 minutes of scarification with sulfuric acid (98%) and the germination percentage enhanced to 90% and 92.5% for the control treatment (**Singh, S.K., et al., 2011**).

The Department of Forestry and Wildlife, University of Maiduguri conduct an experiment in nursery to check out the effect two pre-emergence treatments affected *Acacia senegal* seed emergence. The first treatments involved soaking the seeds in 100°C warm water for 5, 10, and 15 minutes and second treatment in cold water (room temperature) for 8, 12, and 24 hours. The experimental results shows that pre-treatment with cold water have no discernible change in seed germination with exposure time, but the highest mean germination 6.3077 were observed with 12 hours of exposing. Similarly, seed exposure with hot water for 10 minutes shows highest mean germination of 7.500 in *Acacia senegal* (**Usman, A., et al., 2010**).

The experiment was conducted to determine the viability of seeds of *Acacia senegal* through germination in the nursery. The pre-treatments includes soaking in hot water at varying degrees and soaking time, micropylar, distal and circumference cuts on seeds, H₂SO₄ and HCl treatments with varying concentrations and durations of immersion. The laboratory results shows the germination percentage of soaking of seeds in 50% concentrated H₂SO₄ is 89.0% and those cut at circumference shows highest germination of 92.0% (**Zubairu, S.U., 2014**).

The effects pre-treatments of hot water treatment, growing media, and sowing depth on seed germination and seedling growth of *Acacia senegal* were studied in order to maximize seedling production for reforestation of degraded dry land. Three sowing depths treatments (2, 4 and 6 cm) were also investigated. The split plot greatly affected the germination percentage of the seeds and the growth of the seedlings; the emergence time of the seedlings also increased with sowing depth. Untreated seeds sown in sand soil at a depth of 2 cm produced the maximum Cumulative Germination Percentage (CGP) of 100%, whereas seeds pre-watered and sown in sand soil at a depth of 6 cm produced the lowest CGP of 8%.

The maximum reported CGP for the treatment took about 17 days in farm and forest soils but 18 days in sand soil before the untreated seeds put at 2 cm depth in sand soil completely sprouted on the seventh day after planting. The seedlings growing in forest soil had greater height and more branches. In all of the examined growing conditions, it

was determined that 2 cm was the ideal sowing depth for the species among the depths considered. Sandy soil was also discovered to be the best growing medium for untreated seeds placed at a depth of 2 cm.

The germination characteristics of seeds from *Acacia senegal* were not significantly changed by pre-sowing treatment. Untreated seeds had a greater germination percentage than pre-treated seeds (averaged across growth conditions and sowing depth). The percent of germination of the seeds pre-treated for 5 minutes before to sowing was higher than that of the seeds pre-treated for 10 minutes. When *Acacia senegal* seeds are soaked in cooked water, the rate of germination is observed to be lowered. This observation may be attributed to a temporary or permanent damage to the internal structure and/or metabolic machinery of the seed caused by prolonged exposure to hot water. This conclusion is consistent with the results of **Nasroun and Al-Mana (1992)**, who demonstrated that pre-sowing seed treatment with boiling water of the *Acacia saligna*, *Acacia seyal*, *Acacia farnesiana*, and *Acacia tortilis* species did not significantly improve germination percent. In a comparable manner, **Mekuria (1998)** found that seeds of *Acacia senegal*, *Acacia seyal* and *Acacia tortilis* left untreated (control) exhibited considerably higher total germination percentages than seeds that had been pre-treated in boiling water for 1, 3, and 5 minutes, respectively. Similar type of studies were carried out by **Masamba, 1994 and Okunomo and Bosah, 2007** have confirmed that pre-sowing treatment of *Acacia Senegal* seeds at different temperatures and for different lengths of time did not increase germination percentage.

The investigation were carried out by Danthu et al. (1992) also obtained significantly higher germination rates for seeds of untreated *Acacia senegal* compared with seeds treated in boiling water. In contrast, others reported that germination rates of various acacia species, including *Acacia senegal*, were improved by immersion in boiling water (**Larsen, 1962; Magnani et al., 1993; Demel, 1996; Aref, 2000**). For example, **Sanyang et al. (2008)** reported that the 10 min pre-treatment of *Acacia senegal* seeds takes least time to germinate, time to 50% emergence and the shortest time to last observed emergence also had the highest percentage emergence of 71%. The results of this study showed that increasing the soaking time from 5 minutes to 10 minutes in hot water reduced the germination capacity of *Acacia senegal* seeds. On the other hand in germination characteristics, there was no significant effect on the number of seedling branches but a negative effect on the seedling height. The control seeds had better grain height than the pretreated seeds. It appears that seed pretreatment did not improve seed germination, but did affect seedling growth.

3. Materials and Methods

3.1. Experimental site

The seed germination tests were performed in seed germination Laboratory of Silviculture and Forest Management, ICFRE - Arid Forest Research Institute, Jodhpur.

3.2. Source of seeds

The seeds of *Acacia senegal* were obtained from the different sites namely Boli Hill Base, SawaiMadhopur; Panjarapol, Infront of goshala, opposite of chamunda mata ki oran, Ghaneraav, Desuri; Nearby Sumer pond, bagor vaan khand, Desuri Range, Pali; Near Ranger office, Fatehpur, Sikar; Samod forest area, Jaipur; CAZRI

Field Jaisalmer Highway, Jodhpur, Nearby 12 mile area, Jaisalmer Highway, Jodhpur; Medicinal Plant Conserve Area, Jaisalmer road, Jodhpur; Osia, Jodhpur; Mandana, Singhpuri, Kota; PeechkiBawadi, Hindoli, Bundi; Shahapura jajiya kala-2, Jaipur and Sintholi Nursery, SawaiMadhopur. The seeds were stored in closed container at about 10°C after cleaning of seeds.

3.3. Experimentation and Results

3.3.1. Experimentation

Seed Characters, such as Length, width and thickness of the *Acacia senegal* seeds were recorded in millimeter with the help of vernier caliper. With the help of seed counter machine seeds per kilogram were calculated. Laboratory test on the germination response of *Acacia senegal* seed stored-germination treatments of Hot water, GA₃ (500 and 1000 ppm) and IBA 500 and 1000 ppm) compared to untreated seeds (control).

3.3.2. Soaking

Twenty seeds in hot water for 15 min. Twenty seeds were also soaked in GA₃ (500 and 1000 ppm) and IBA GA₃ (500 and 1000 ppm) for 6 hours. All the pre-treated and untreated seeds were thoroughly washed in distilled water and were placed in germination tray. The experiment was carried out at room temperature in the laboratory. Seeds were considered germinated upon plumule emergence. The number of seeds that germinated was recorded while the percentage seed germination was calculated.

3.3.3. Results

Among 14 different locations seed length, width & thickness. Seed length was minimum in Shahpura having average length 7.28 ± 0.76 cm while maximum was found in Samod forest area with average length 10.26 ± 0.68 cm. Width of seeds vary from 6.4 ± 0.6 cm in Shahpura to 9.15 ± 0.64 is Hindoli, Bundi in region. Seed thickness was found highest in Jaisalmer highway are having 2.08 ± 0.29 cm while lowest in Samod forest area with 1.12 ± 0.2 cm thickness. Seeds per kilogram vary from 8057 in Hindoli, Bundi 13661 in Desuri range. Moisture percentage was 3.70 percent in medicinal plant conserve area Jodhpur to 6.36 percent in Jaisalmer highway region.

Seed germinated in laboratory condition Show different ways with various growth regulars. In Boli IBA 500 ppm given 75 percent while hot water treated seeds show only 40 percent. In Gharmerav Desuri seeds GA₃ 500 ppm treated seeds grows 40 percent germination & same with IBA 1000 ppm whereas . Germination in hot water, IBA 500 ppm and GA₃ 1000 ppm shows 50 percent germination. In bagor van khanddesuri GA₃ 1000 ppm given 23 percent germination while without treated seeds given 66.7 percent

In Fatehpur seeds nearly all treatments viz (control Hot Water, GA₃ 1000 ppm, IBA 500 ppm) given 80 percent while IBA 1000 ppm treated seeds given 85 percent germination. In GA₃ 500 ppm treated seeds, germination was 75 percent. Samod forest area seeds treated with IBA 500 ppm and IBA 1000 ppm shows 40 percent germination. CAZRI field, Jaisalmer highway seeds shows 35 percent germination in GA₃ 1000 ppm while IBA 1000 ppm shows 60 percent germination.

Seeds collected from 12 mile area, Jaisalmer highway shows lowest germination with IBA 500 ppm treatment having 45 percent while in control it was 80 percent In medicinal plant conserve area Jaisalmer seeds shows 15

percent germination in control while IBA 500 ppm treated seeds show 45 percent germination. In the same area seeds collected in 2020 shows result in control with 83.3 percent & 85 percent in cold water & IBA low ppm. GA₃ 500 ppm shows 81.67 percent germination while GA₃ 1000 ppm shows 73.33 percent germination.

Seeds collated from Ossia shows 35 percent germination in IBA 500 ppm while control & GA₃ 500 ppm given 70 percent germination. Highest germination was found with GA₃ 1000 ppm treatment. In Mandana, Kota seeds lowest germination was in IBA 500 ppm treated seeds with 35 percent and highest in GA₃ 1000 ppm treated seeds.. In Peechki Bawri, Hindoli, Bundi seeds IBA 1000 ppm treated seeds shows 40 percent while in IBA 500 ppm it gives 70 percent germination. In fact control seeds also show 70 percent germination In Shahpura seeds GA₃ 1000 ppm. shows only 15 percent germination while IBA 500 ppm shows 65 percent germination. Control shows 45 percent germination under lab conditions.

Table 1. *Acacia senegal*- Seed parameter collected from various locations (Seed Moisture and Seed per Kg)

Sl. No.	Location	GPS	Date of Collection	Length	Width	Thickness	Seed per kg	Fresh weight of 100 seeds (in gram)	Dry weight of 100 seeds (in gram)	Moisture Percentage (in %)
1	Boli Hill Base, Sawai Madhopur	N 26° 20' 550" E 76° 13' 389"	19-01-2022	9.93 ± 0.53	8.59 ± 0.91	1.68 ± 0.21	9463	10.702	10.567	6.26
2	Panjarapol, Infront of goshala, opposite of chamundamatakioran, Ghaneraav, Desuri	N 25°22'96.68" E 75°50'10.65"	05-01-2022	9.06 ± 1.03	8.45 ± 0.77	1.97 ± 0.26	9143	11.07	10.937	5.20
3	Nearby sumer pond, bagorvaankhand, Desuri Range	N 25°37'10.8" E 73°63'24.98"	04-01-2022	7.54 ± 1.19	6.68 ± 0.98	1.32 ± 0.2	13661	7.36	7.32	5.54
4	Near Ranger office, Fatehpur	N 27°58'030" E 74° 50'218"	12-05-2022	8.81 ± 0.67	8.54 ± 0.53	1.89 ± 1.22	8573	11.762	11.665	5.82
5	Samod forest area	N 27°192'74.54" E 75°79'94.772"	03-03-2022	10.26 ± 0.68	8.43 ± 0.75	1.12 ± 0.2	9545	11.18	10.477	6.29
6	CAZRI Field Jaisalmer Highway	N 26°31'98.73" E 72°96'40.81"	19-01-2022	8.88 ± 0.98	7.72 ± 0.78	1.97 ± 0.18	9713	10.3	10.295	6.05
7	Nearby 12 mile area, Jaisalmer Highway	N 26°32'90.35" E 72°93'48.6"	19-01-2022	9.88 ± 1.04	8.38 ± 0.9	2.08 ± 0.29	9486	10.58	10.542	6.36
8	AFRI Medicinal Plant Conserve Area, Jaisalmer road	N 26°32'18.24" E 72°95'38.72"	19-01-2022	8.58 ± 0.7	7.83 ± 0.52	1.83 ± 0.16	11279	8.872	8.866	6.07
9	Medicinal Plants Conserve Area Jodhpur	N 26° 19.12 E 72° 57.17	16-12-2020	9.07 ± 0.7	7.93 ± 0.62	1.91 ± 0.24	9363	11.09	10.68	3.70
10	Ossia	N 26°715.'227" E 72°89'74.47"	04-04-2022	7.28 ± 0.76	6.68 ± 0.98	1.92 ± 0.25	8444	12.018	11.843	4.76
11	Mandana, Singhpuri, Kota	N 24°53.301' E 75°58.742'	10-06-2022	9.71 ± 0.67	8.55 ± 0.67	1.99 ± 0.25	8445	12.017	11.842	5.46

12	Peechki Bawadi, Hindoli, Bundi	N 25°37.552' E 76°28.338'	12-06-2022	10 ± 0.68	9.15 ± 0.64	2.06 ± 0.25	8057	13.014	12.412	4.63
13	Shahapurajajiya kala-2	N 27°40'29.993" E 75°96'89.489"	03-03-2022	7.28 ± 0.76	6.4 ± 0.6	1.93 ± 0.25	8422	12.451	11.874	4.63
14	Sintholi Nursery	26° 33' 152" 76° 25' 445"	17-01-2022	9.98 ± 0.59	8.38 ± 0.64	1.54 ± 0.29	12162	9.658	8.222	4.87

Table 2. Seed Germination in Laboratory conditions

Sl. No.	Location	GPS	Date of Collection	Treatment	Germination Percentage	Total Mean germination time	Total Germination value	Average Mean germination time	Average Germination value
1	Boli Hill Base	N 26° 20' 550" E 76° 13' 389"	19-01-2022	Control	70	112.85	2380.5	5.1	108.2
				Hot water	40	75.9	960.0	3.5	43.6
				GA ₃ 500 ppm	50	109	1121.6	5.0	51.0
				GA31000 ppm	55	91.75	1797.2	4.2	81.7
				IBA 500 ppm	75	128.9	2893.3	5.9	131.5
				IBA 1000 ppm	80	121.4	3162.2	5.5	143.7
2	Panjarapol, Infront of goshala, opposite of chamundamat akioran, Ghaneraav, Desuri	N 25°22'96.68" E 75°50'10.65"	05-01-2022	Control	45	33.35	482.86	2.38	34.49
				Hot water	50	34.7	554.37	2.48	39.6
				GA3500 ppm	40	30.6	395.76	2.19	28.27
				GA31000 ppm	50	35.15	557.38	2.51	39.81
				IBA 500 ppm	50	38.05	556.93	2.72	39.78
				IBA 1000 ppm	40	31.4	374.71	2.24	26.76
3	Nearby sumer pond, bagorvaankha nd, Desuri Range	N 25°37'10.8" E 73°63'24.98"	04-01-2022	Control	66.7	50.43	401.38	3.6	28.67
				Cold water	53	4.4	0.03	0.31	0
				Hot water	50	4.07	0.77	0.29	0.05
				GA3500 ppm	43.3	3.41	0.04	0.24	0
				GA31000 ppm	23	1.51	2.27	0.11	0.16
				IBA 500 ppm	23.3	1.75	0.72	0.13	0.05
				IBA 1000 ppm	26.7	1	0.48	0.14	0.03
4	Near Ranger office, Fatehpur	N 27°58'030" E 74° 50'218"	12-05-2022	Control	80	196.85	2106.3	8.95	95.74
				Hot water	80	190.3	2295.06	8.65	104.32
				GA3500 ppm	75	182.5	2205.21	8.3	100.24
				GA31000 ppm	80	191.95	2228.59	8.73	101.3
				IBA 500 ppm	80	193.75	2275.14	8.81	103.42
				IBA 1000 ppm	85	206.75	2272.96	9.4	103.32
5	Samod forest area	N 27°192'74.54" E 75°79'94.772"	03-03-2022	Control	80	194.95	2722.8	8.86	123.76
				Hot water	55	134.65	1694.91	6.12	77.04
				GA3500 ppm	80	196.35	3512.48	8.93	159.66
				GA31000 ppm	70	169.65	2911.78	7.71	132.35
				IBA 500 ppm	40	94.05	1135.32	4.28	51.61
				IBA 1000 ppm	40	94.9	1054.29	4.31	47.92
6	CAZRI Field Jaisalmer Highway	N 26°31'98.73" E 72°96'40.81"	19-01-2022	Control	40	98.05	1183.6	4.46	53.8
				Hot water	45	112	1143	5.09	51.95
				GA3500 ppm	45	110.8	1195.85	5.04	54.36
				GA31000	35	87	894.65	3.95	40.67

				ppm					
				IBA 500 ppm	60	145.35	1665.3	6.61	75.7
				IBA 1000 ppm	60	145.6	1643.67	6.62	74.71
				Control	80	198.9	2032.79	9.04	92.4
7	Nearby 12 mile area, Jaisalmer Highway	N 26°32'90.35" E 72°93'48.6"	19-01-2022	Hot water	75	185	1933.18	8.41	87.87
				GA3500 ppm	75	186.65	1904.19	8.48	86.55
				GA31000 ppm	65	161.05	1677.16	7.32	76.23
				IBA 500 ppm	45	112	1143	5.09	51.95
				IBA 1000 ppm	55	135.7	1459.1	6.17	66.32
8	Medicinal Plant Conserve Area, Jaisalmer road, Jodhpur	N 26°32'18.24" E 72°95'38.72"	19-01-2022	Control	15	36.75	422.63	1.67	19.21
				Hot water	35	85.8	964.54	3.9	43.84
				GA3500 ppm	40	98.2	1033.44	4.46	46.97
				GA31000 ppm	30	74.5	771.08	3.39	35.05
				IBA 500 ppm	45	110.45	1233.49	5.02	56.07
				IBA 1000 ppm	30	73.75	837.06	3.35	38.05
9	Medicinal Plants Conserve Area Jodhpur	N 26° 19.12 E 72° 57.17	16-12-2020	Control	83.33	373.55	181.25	11.67	0.36
				Cold water	85	419.93	2628.28	13.12	82.15
				Hot water	81.67	347.17	2865.45	10.85	89.55
				IBA-500	78.33	350.25	3227.15	10.95	100.85
				IBA-1000	85	398.15	3019.49	12.44	94.36
				GA3-500	81.67	375.28	2806.83	11.73	87.71
				GA3-1000	73.33	335.25	2716.86	10.48	84.9
10	Osia	N 26°715.'227" E 72°89'74.47"	04-04-2022	Control	70	162.75	2701.65	7.4	122.8
				Hot water	80	186.15	2524.31	8.46	114.74
				GA3500 ppm	70	159.4	2869.2	7.25	130.42
				GA31000 ppm	85	197.45	2795.56	8.98	127.07
				IBA 500 ppm	35	71.45	1172.97	3.25	53.32
				IBA 1000 ppm	45	99.7	1470.58	4.53	66.84
11	Mandana, Singhpuri, Kota	N 24°53.301' E 75°58.742'	10-06-2022	Control	70	155.1	3351.751	7.05	152.35
				Hot water	70	155.1	2412.6	7.05	109.66
				GA3500 ppm	75	165.05	2620.705	7.502273	119.1229
				GA31000 ppm	80	179.7	2824.713	8.17	128.4
				IBA 500 ppm	35	77.55	1190.393	3.53	54.11
				IBA 1000 ppm	40	89.9	1062.96	4.09	48.32
12	Peechki Bawadi, Hindoli, Bundi	N 25°37.552' E 76°28.338'	12-06-2022	Control	70	166.6	2921.908	7.57	132.81
				Hot water	60	146.7	2383.208	6.67	108.33
				GA3500 ppm	60	146	1924.545	6.64	87.48
				GA31000 ppm	55	133.15	1408.061	6.052273	64.00278
				IBA 500 ppm	70	164.75	1852.381	7.49	84.2
				IBA 1000 ppm	40	93.75	1040.625	4.26	47.3
13	Shahapurajaji ya kala-2	N 27°40'29.993" E 75°96'89.489"	03-03-2022	Control	45	105	937.5	4.77	42.61
				Hot water	35	83	712.42	3.77	32.38
				GA3500 ppm	30	70.35	619.08	3.2	28.14
				GA31000 ppm	15	35.7	303.45	1.62	13.79
				IBA 500 ppm	65	148.35	1401.7	6.74	63.71
				IBA 1000 ppm	40	89.65	834.6	4.08	37.94

4. Conclusion

During study it was revealed that seed size and other parameters vary with the place of seed collection. Even in same area from different locations seed size varies. It varies from 8057 seeds per kilogram to 13661 seeds per kilogram. There was no significant relationship in between seed size and germination percentage. Even seed collected in different years from same location like that of medicinal plant area, Jodhpur differ in behavior. Under lab condition also different growth regulators shows varied results in germination which indicate that seed germination not only differ with growth parameters or treatment but also varies due to their genetic characteristics. Seeds germination vary from 40 to 80 percent. It is recommended that Phonology and reproductive biology of seed formation should be studied properly. It is also emphasize that based on soil and moisture along with topography seed germination study in correlation with their germination behavior needs to be studied in detailed to understand germination behavior.

Declarations

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The study has not received any funds from any organization.

Competing Interests Statement

The authors have declared no competing interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

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