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Farmers' Perception of *Calotropis procera* on the Soil and Productivity of Off-Season Sorghum (*Sorghum durra*) in Magoumai, Gawar and Laf, Far North Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Author ALD wrote the original version of the manuscript. Authors T and MC designed the survey sheet and contributed to the explanation and discussions on the results. All authors read and approved the final manuscript.

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ABSTRACT

The present study focuses on farmers' perception of *Calotropis procera* on the productivity of off-season sorghum in Magoumaï, Gawar and Laf (Far North Cameroon). The main objective of this work is to contribute to a better understanding of the impact of *C. procera* on the soil, growth, and yield of off-season sorghum. Ethnobotanical surveys were carried out in three villages, where 345 individuals were randomly selected. The data collected were analyzed in terms of the average percentage of respondents reporting the impact of *C. procera* on soil and off-season sorghum productivity. This analysis showed that *C. procera* impacts the soil: 57.67 ± 1.52% and 39.67 ±

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4.35% respectively of respondents felt that *C. procera* absorbs soil moisture and impoverishes it. For off-season sorghum development stages, *C. procera* has an influence on plant growth, with an average percentage of 95 ± 3.05%. For the crop yield component of off-season sorghum, panicle weight averaged 47 ± 4.58%. This work shows the impact of *C. procera* on the soil. Given the impact of *C. procera* on the soil and the productivity of off-season sorghum, it would be important to try to slow down the effect of *C. procera* colonization in off-season sorghum fields.

Keywords: Farmer perception; Calotropis procera; productivity; off-season sorghum; pharmacopoeia.

1. INTRODUCTION

Calotropis procera is a species of the Apocynaceae family found in tropical Africa, the Indian Ocean islands and northern South Africa [1]. It's extremely wide range suggests that the shrub is endowed with great ecological flexibility [2]. It is found throughout the Sudano-Sahelian zone [3]. *C. procera* came from the margins of the desert and is gradually moving southwards [4]. It is very common in all dry regions of East and West Africa and part of Central Africa [1]. Roots, bark, latex, leaves, and flowers are all used in traditional medicine [5]. Use in traditional pharmacopoeia has shown that the extract from the flowers of this species causes degeneration of the sexual organs of individuals, and the decoction of dried leaf powder cures coughs and madness [6]. In most developing countries, rural populations use it as a source of wood and food [7]. However, *C. procera* destabilizes ecosystems in arid environments [8].

It is in this sense that Gillet [3] in his Ecological and ethnobotanical note on *C. procera*, presents it as a colonizer of ruined lands' where the most prosperous individuals are seen on the poorest soils". It appears as an indicator species for desertification of the Sudano-Sahelian zone [9]. It also persists widely in crop fields and can therefore have harmful effects on crops through allelopathy [10]. Off-season sorghum is an important cereal in the cropping systems and diets of many sub-Saharan African countries [11]. The northern zone of Cameroon is one of the most important production areas of this cereal [12]. In the Far North, off-season sorghum has developed rapidly and currently represents 40% of total cereal production. Sorghum occupies a privileged position in time and space because it does not compete with that of cash crops (cotton, peanuts, and rice) and occupies land which is generally not devoted to other crops [13,14,15]. This cereal gives higher yields than rainfed crops, and allows a second cereal harvest in the middle of the dry season [16]. However, its implementation requires the cutting and grubbing of trees, necessary conditions for the establishment of the crop, in order to reduce competition for water and limit the presence of perches for seed-eating birds [17]. Likewise, the permanent exploitation of cultivated plots without fallowing has led to problems of soil degradation. It is in this context of soil degradation that we are interested in indicator tree species.

In Cameroon in general, more precisely in the Far North Region, few studies have been carried out concerning the impact of *Calotropis procera* on the productivity of off-season sorghum, hence the absence of scientific information on its impact on off-season sorghum productivity. The present study aims to fill this gap. Therefore, the main objective of this work is to contribute to a better knowledge of the impact of *C. procera* on off-season sorghum cultivation. Specifically, it is about revealing the farmers perception of *C. procera* on the soil and productivity of off-season sorghum.

2. MATERIALS AND METHODS

2.1 Study Site

The study is carried out in three villages in the Far North Region, Cameroon (Magoumaï, Gawar and Laf) respectively in the Districts of Bogo, Mokolo and Moutourwa. Bogo is a district of Diamaré located between 10°44' North, 14°36' East. It is limited to the South-West by the district of Dargala, to the North-East by the district of Maga, to the North by Petté, to the North-West by the Commune of Maroua 3rd and to the South-East by the district of Moulvoday. It covers an area of 93,000 ha for a population of 95,230 inhabitants [18]. The climate is of the Sahelian type characterized by a dry season which lasts seven months with high temperatures (28-35°C) and a rainy season of five months. The relief consists of a large plain (310-330 m) and a few hills to the southwest in the canton of Bgalaf (HosséréGoboré, 493m) and to the northwest in the canton of Balda (Hosséré Balda, 679m) [19]. The average annual rainfall varies between 95mm and approximately 835mm. The ethnic groups encountered are the Fulani, Guiziga,

Moufou, Musghun, and Sirata. Economic activity is marked by agriculture, livestock, and trade.

Mokolo is a district of Mayo-Tsanaga located between 10°44' North, 13°48' East. It is limited to the North by Koza and Mozogo, to the South by Mogodé and Hina, to the East by Gazawa and Souledé-Roua and the West by Bourha and the Republic of Nigeria. It covers an area of 1,650 km2 for a population of 310,000 inhabitants [18]. The climate is Sahelian, characterized by a long dry season of seven months and a short rainy season of five months. Harmattan winds blow from the Sahara towards the south in December and January. The temperature is high during the dry season around 43.3°C [20]. The relief is marked by a set of high-altitude plateaus characteristic of the Mandara Mountains which are part of the mountain ranges constituting the Cameroonian ridge. The average rainfall varies between 700 mm and 1000 mm. The different types of soils present are: clay soils, sandy clay soils and sandy soils. The ethnic groups encountered are the Mafa, the Fulani, the Moufou, and the Kapsiki. The main activities of the populations of this region are dominated by agriculture, livestock breeding, and small commerce (UNDP, 2002). Moutourwa is a district of Mayo-Kani located between 10°11' North, 14°10' East. The climate of the commune is Sudano Sahelian type, characterized by two seasons: A long dry season lasting approximately eight (08) months, going from October to May and a rainy season of four months covering the months of June to September. Annual rainfall varies between 700 and 1000 mm with an average of 800 mm. The average annual temperature is 34°C, with March, April and May as the hottest months and December, January and February as the coldest months. The relief of the commune of Moutourwa is characterized by vast plains crossed by a few mountain ranges which peak at 400 meters [20]. The different types of soils encountered are: vertisols (Karal), planosols (Hardé), ferruginous soils and hydromorphic soils (Yaéré) The main activities of the populations of this region are dominated by agriculture, livestock and small commerce. The ethnic groups encountered are Guiziga, Moufou, Mafa, and Toupouri [20].

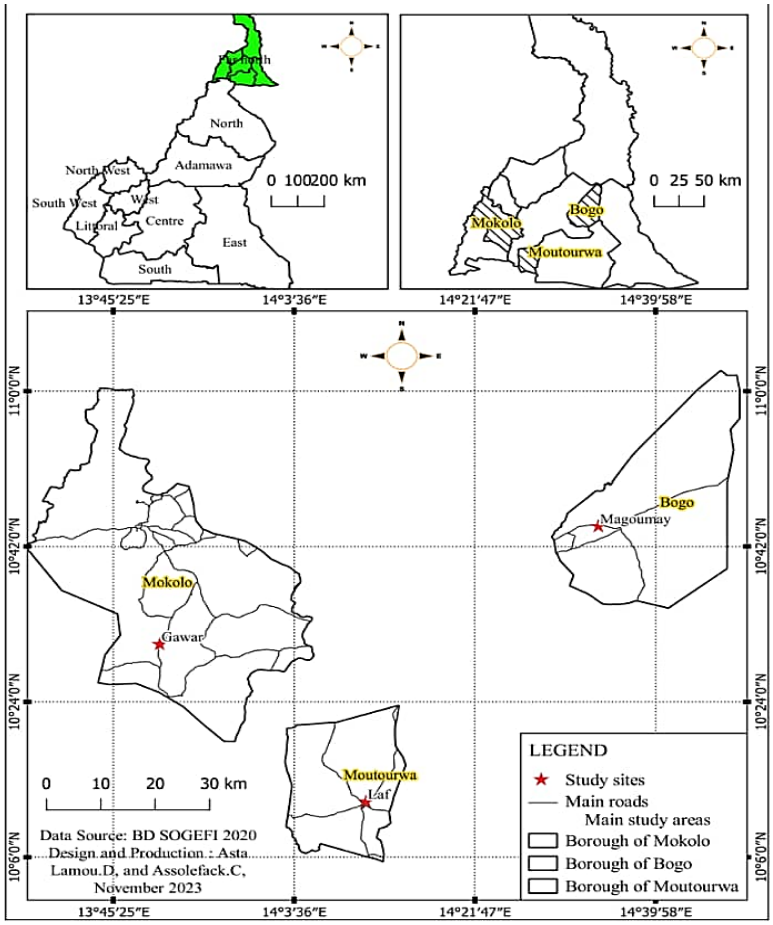

Fig. 1. Study site

2.2 Field Data Collection

Data collection took place in the three study area sites. It consisted of carrying out surveys with traditional chiefs and producers. These sites were chosen based on accessibility, the presence of off-season sorghum fields and the density of *C. procera*.

2.3 Sampling Method

This interview was carried out using the probabilistic method where the choice of surveys was random. This made it possible to embrace all layers of respondents.

2.4 Sample size

The people interviewed are previously defined using the following formula: $n = (t^2p \times P (1 – P) \times N) / (t^2p \times P (1 – P) + (N–1) \times y^2)$ n: sample size: size of the actual or estimated target population; P: expected proportion of a population response or actual proportion. In our case the study is multi-criteria and has not been carried out, it is set at 0.05 by default, which allows us to have the largest possible sample; tp: sampling confidence interval y: margin of sampling error.

2.5 Investigations

The interview was carried out in the form of a structured and semi-structured interview, which allowed us to guide the procedures. The questionnaire included three types of questions: open questions through which the respondents freely expressed their opinion; closed questions to be answered with Yes or No, and leading questions in which the respondent will choose one or more answers. This interview was based on a questionnaire previously tested (Martin and Segalen, 1996) with traditional chiefs and individuals belonging to large communities (local populations). The interview was based on headings such as: identification of interviewees, farmers' perception of *C. procera* on soil fertility, people's perception of the impact of *C. procera* on the productivity of off-season sorghum.

To better understand the impact of *C. procera* on off-season sorghum, surveys are carried out in three villages of the study sites.

The criteria for choosing the people surveyed were (i) at least 20 years old and (ii) resided in the study area for at least 15 years.

A et B: Farmer Surveys

A total number of 345 individuals in three villages were surveyed: 95 in Laf, 110 in Gawar and140 in Magoumai.

2.6 Data analysis

The percentage of respondents on the impact of *C. procera* (Maregesi et al., 2007) was calculated using the formula: S = (n/N) *100

Where,
S: calculated response percentage;
n: number of people who gave a positive response (Yes) for the use of the organ concerned;
N: total number of people surveyed.

The results are statically analyzed using Statgraphics 5.0 software, which made it possible to perform the analysis of variance (ANOVA) and Duncan’s test.

3. RESULTS AND DISCUSION

The ethnicity of the populations surveyed in our explored sites is represented in Table 1. Generally, the respondents from these three localities are of Guiziga origin (40.67 ± 13.20%). However, there are other ethnic groups such as the Fulani with an average percentage of 38.54 ± 19.86% followed by the Moufou (9.07 ± 4.45%),

Mafa (5.72 ± 3.46%). Toupouri (4.62 ± 5.08%), Musgum (1 ± 1.73%), and Sirata (0.33 ± 0.57%). The ANOVA showed a significant difference between ethnic groups ($p<0.05$). This result could be explained by the fact that the Guiziga are indigenous and have enough land for cultivation, thus promoting their economic development, while the Peulhs are mostly nomadic breeders and the Toupouris come from Mayo-Danay, because they are areas with a source of development.These results are consistent with the work reported by Kapi et al. [21] who affirm that the Guiziga are the most numerous in the Diamaré plain and are the indigenous peoples of Laf.

In all of these villages, the average percentage of respondents by age group is low 7 ± 1% in the interval at 20-29 years, followed by 10 ± 1% in the interval 30-39 years, comes 18.67 ± 4.16% in the interval 40-49 years and finally 64.33 ± 6.02% for the age group greater than or equal to 50 years (Table 2). The ANOVA shows a significant difference between the age groups ($p<0.05$). The majority of respondents is concentrated in the age group greater than or equal to 50 years (65.66±4.53%). This could be because older people are the heads of households who must feed their families. These results corroborate those reported by Rousgou [22] from the Department of Mayo-Kani where people in the age group between 50 and 60 years are the majority in agriculture.

Regarding the activities of the respondents, 77.73 ± 3.05% of respondents have agriculture as their main activity, followed by 17.33 ± 1.53% of respondents as cattle breeders and finally 5.33 ± 2. 51% of respondents trade (Fig. 2). The ANOVA shows a significant difference between the activities of the population surveyed ($p<0.05$). This situation is understandable insofar as agriculture feeds them and remains the main source of income for the respondents who associate it with livestock farming. Livestock breeding is the activity which is parallel to agriculture because cow dung is used as manure in the fields and crop residues as fodder for animals. This result corroborates that of Kemeuze [23] who showed that agriculture and livestock breeding constitute the main daily activities of the populations of the Far North of Cameroon.

Fig. 3 represents the respondents' perception of the impact of *C. procera* on Vertisol. The ANOVA, however, shows that there is a significant difference between the impacts of *C. procera* on the soil ($p<0.05$). Generally speaking, 3 ± 3.05% of respondents judge that *C. procera* fertilizes the soil, others estimate that the species impoverishes the soil with an average percentage of 39.67 ± 4.35% and 57.67 ± 1.52% of respondents think that *C. procera* removes moisture from the soil. The high proportion of respondents leans towards soil aridity, followed by the depletion of soil mineral elements by *C. procera*. In fact, the evapotranspiration surface of the species is larger and it captures morelight and nutrients (air nitrogen, and phosphorus) compared to the cultivated plant. This result disagrees with that of Manssour et al. [11] on the productivity of sorghum in a growing system based on *Acacia senegal*.

Table 1. Distribution of respondents by ethnicity (%)

Ethnic groups	Magoumai	Gawar	Laf	Mean± Diff
Guiziga	38	29	55	40.367 ± 13.20^{b}
Peulh	51	49	15.63	38.54 ± 19.86^{b}
Moufou	4.32	13	10	9.07 ± 4.45^{a}
Musgum	3	0	0	2.33 ± 1.73^{a}
Mafa	2.13	6	9.04	5.72 ± 3.46^{a}
Sirata	4,18	0	0	0.33 ± 0.57^{a}
Toupouri	1,61	3,33	10,33	4.62 ± 5.08^{a}

Means ± errors assigned with different superscripts are significantly different at the 5% threshold

Table 2. Distribution by age group (%) of populations

Age range (years)	Magoumai	Gawar	Laf	Avg ± Diff
20-29	8	4	7	6.33 ± 2.08^{a}
30-39	15	9	10	11.33 ± 3.21^{ab}
40-49	22	19	13	18.00 ± 4.58^{b}
≥50	55	68	70	64.33 ± 8.14^{c}

Numbers assigned different letters are significantly different at the 5% threshold

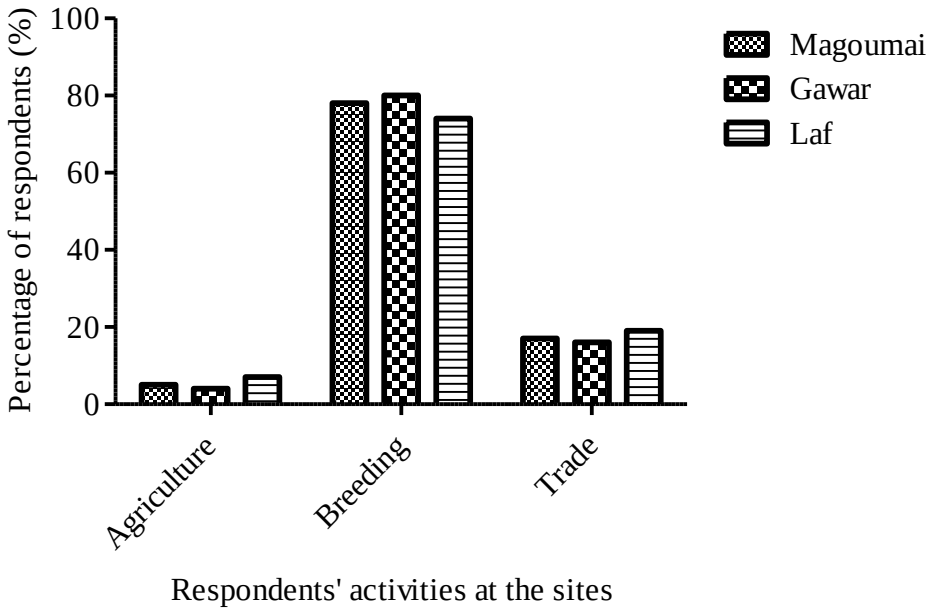

Fig. 2. Population activities in the different sites

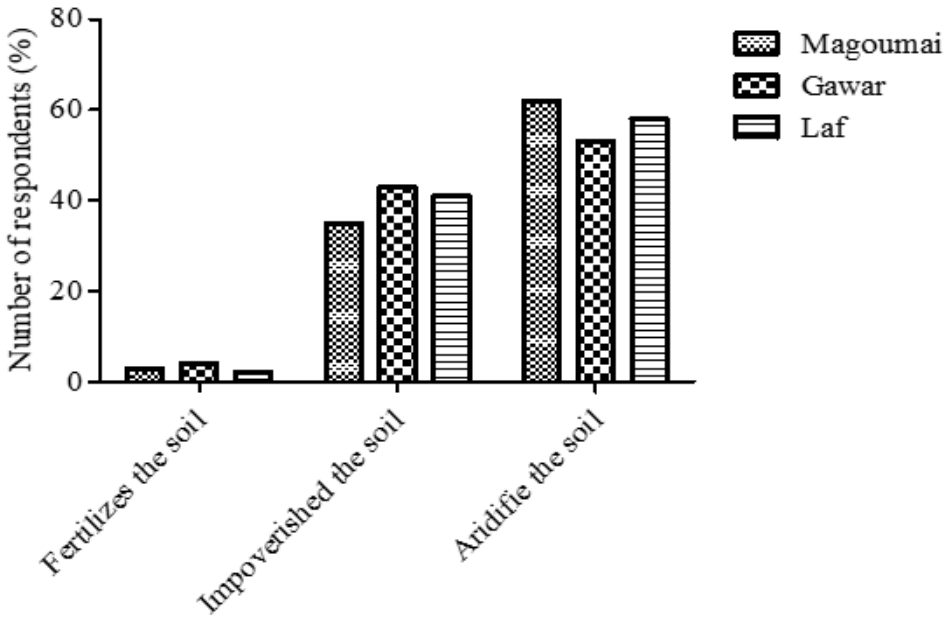

Fig. 3. Influence of *Calotropis procera* on soil

Table 3. Impact of *C. procera* on the development stages of transplanted sorghum

Plant development stage	Magoumai	Gawar	Laf	Moy ± Ecart
Germination	2	1,53	0,37	1,3 ± 0,83[a]
Growth	93	95	99	95 ± 3,05[b]
Reproduction	4	3,47	0,65	2,70 ± 1,80[a]

Numbers assigned different letters are significantly different at the 5% threshold

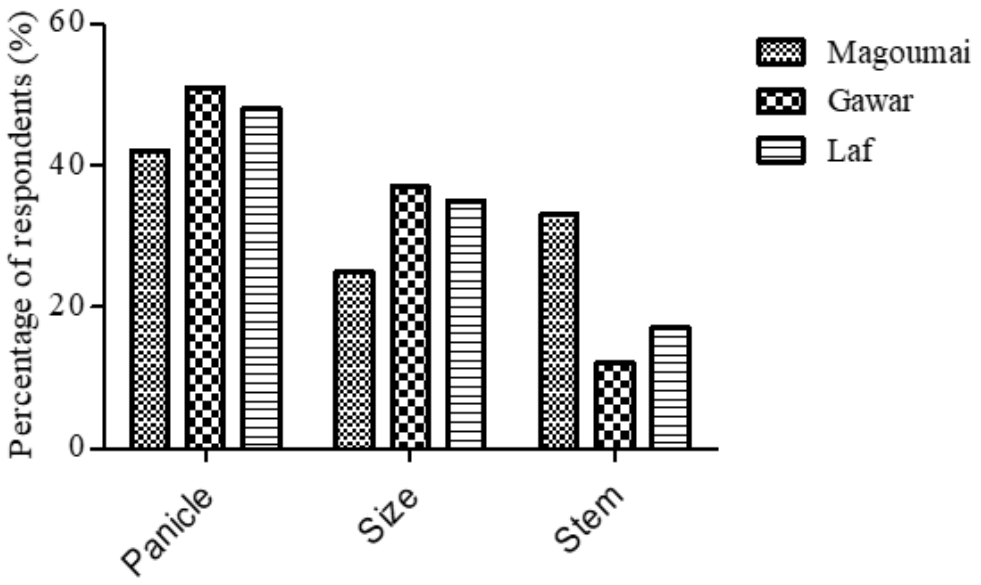

Fig. 4. Impact of *C. procera* on off-season sorghum yields

Table 3 shows the effect of *C. procera* on different developmental stages of muskwaari. According to the respondents, it impacts more during growth (95 ± 3.05%) followed by fruiting (2.70 ± 1.80%) and germination (1.3 ± 0.83%). The analysis of variance shows a significant difference between the stages of plant development ($p<0.05$). The development of the plant takes place in three stages (germination, growth and fruiting). During off-season sorghum growth, it needs water, light and mineral salts. According to the respondents, *C. procera* is competing with the crop at the moment because the size, the diameter at the collar and the number of leaves slow down during this phase.

Fig. 4 represents the impact of *C. procera* on the different off-season sorghum yield parameters across the sites. The ANOVA shows a significant difference between the impacts of *C. procera* on the size, girth, and agricultural yield of off-season sorghum. It appears from this survey that 6.42 ± 32% of respondents believe that *C. procera* reduces the circumference of the transplanted sorghum stem, 20.67 ± 10.96% of respondents believe that it reduces the size of the plant and 47 ± 4.58% think that it reduces the yield of muskwaari. This can be justified by the fact that during growth, the plant competes with *C. procera* for nutrients and water needed for its growth. On vertical soils *C. procera* proves more dangerous because of its powerful root system through which it removes water to the detriment of the transplanted sorghum [4]. This result is not in agreement with those of Manssour et al. [11] who showed that *Acacia senegal* is a legume which establishes symbiosis with rhizobia and mycorrhizal fungi at the root level, is capable of stimulating significant development a great diversity of microbial colonies which are a source of nitrogen and phosphorus in the soil. Concerning the agricultural yield of off-season sorghum in recent years of cultivation, farmers say that it is declining. This could be due to the colonization of off-season sorghum fields by *C. procera* compared to previous years. Indeed, some respondents informed that the presence of *C. procera* impacts the yield of off-season sorghum. The denser *C. procera* is, the lower the yield of off-season sorghum [24].

4. CONCLUSION

In this study we highlighted the farmers perception of *C. procera* on soil and the productivity of off-season sorghum. In view of the results obtained, concerning the ethnicity of the respondents, the Guiziga are the most represented, are indigenous and have enough land for cultivation. According to the age of the respondents, the majority is concentrated in the age group greater than or equal to 50 years. Livestock breeding is the most practiced activity after agriculture. Concerning the stages of development, respondents affirm that *C. procera* has a greater impact during growth and reduces the yield of off-season sorghum. *C. procera* degrades soil through absorption of nutrients and

water. Therefore, we must look for a means of combating the invasion of this species in off-season sorghum fields.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest with respect to the manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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