Effect of Seasonal and Geographical Location on the Secondary Metabolic Contents of *Artemisia afra* and *Artemisia annua*. Anti-plasmodial Properties.

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Introduction

- Malaria remains a global health concern, and natural products are being explored as potential treatments.
- *Artemisia annua* and *A. afra* are two plant species with potential anti-malarial properties, and their secondary metabolites have been extensively studied for their therapeutic effects against malaria and inflammation.
- *Artemisia annua* and *afra* are used as both curative and preventive measure against malaria in Cameroon [1].

Objective

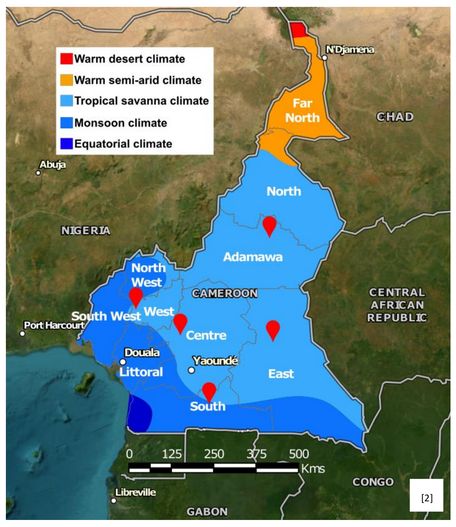
Assess whether there are variations in composition & efficacy based on the geographical locations of collection, aiming to determine if regional differences in *Artemisia* samples hold any significance in their potential as anti-malarial agents.

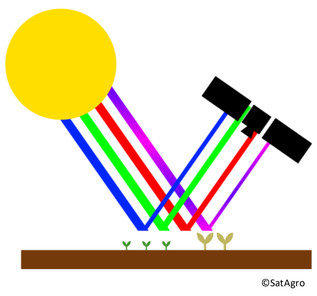
Methods

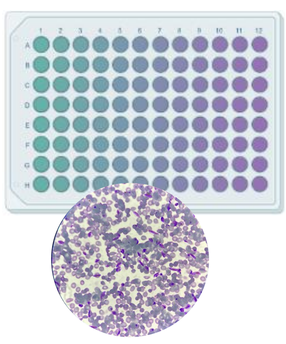
- Ten *Artemisia* samples were collected during the flowering stage from five regions, encompassing both the rainy season (RS) and the dry season (DS).
- Metabolomic profiles, as well as the content of artemisinin and polyphenols, were evaluated using HPLC-DAD (High-Performance Liquid Chromatography with Diode Array Detection).
- In-vitro antiplasmodial assays were conducted on the samples, following the method established by Trager and Jensen [3].
- Characteristics of the collecting site environments were retrieved from multispectral Earth Observation data (Sentinel-2 satellite from the European Copernicus programme) and integrated with the phytochemical and biological information obtained from the samples.
- This cross-linking approach provides a comprehensive understanding of the relationship between the phytochemical composition, geographical origin, and antiplasmodial activity of the Artemisia samples.

Region	Town	Climate	Date of collection RS	Date of collection DS	Date of EO image RS	Date of EO image DS
South	Sangmalima	Savana - Monsoon climate 20°C - 30°C	28-07-21	21-04-22	10-09-21	29-03-22
West	Dschang	Savana - Monsoon climate 18°C - 29°C	07-07-21	13-04-22	25-06-21	06-04-22
East	Bertoua	Savana climate 23°C - 27°C	19-07-21	07-04-22	06-08-21	19-03-22
Center	Bafia	Savana climate 24°C - 28°C	11-07-21	15-04-22	20-07-21	01-05-22
Adamawa	Ngaoundere	Savana climate 26°C - 32°C	26-07-21	17-04-22	22-07-21	08-04-22

Table 1: List of the collect points indicating their climate, the collection dates of the samples and the closest Sentinel-2 images used to infer the NDVI. The QR code link to the Sentinel-2 image of the dry season.







Results & Discussion

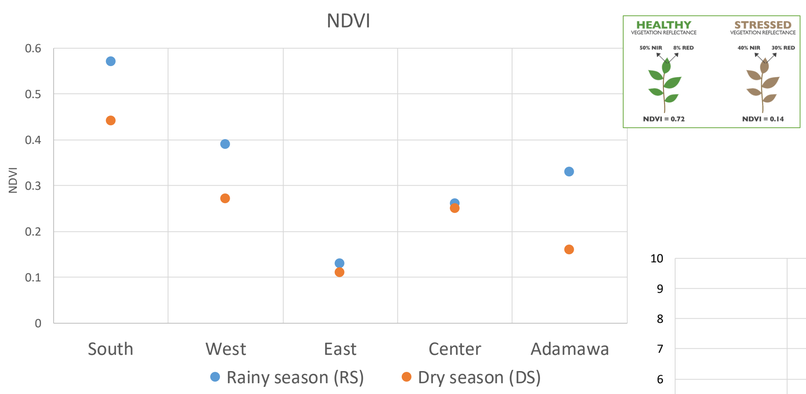


Figure 1: NDVI at the five collecting points and for the two seasons

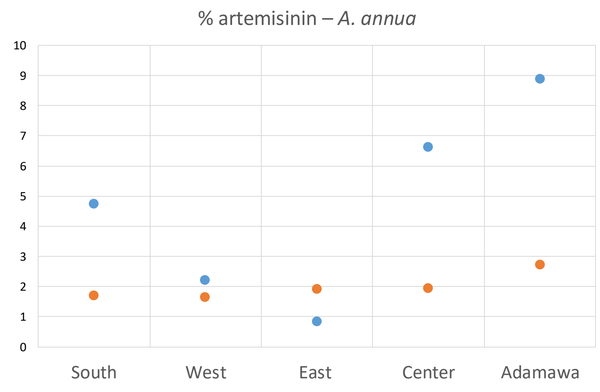


Figure 3: Artemisinin content in *A. annua* collected in rainy (blue) and dry season (orange)

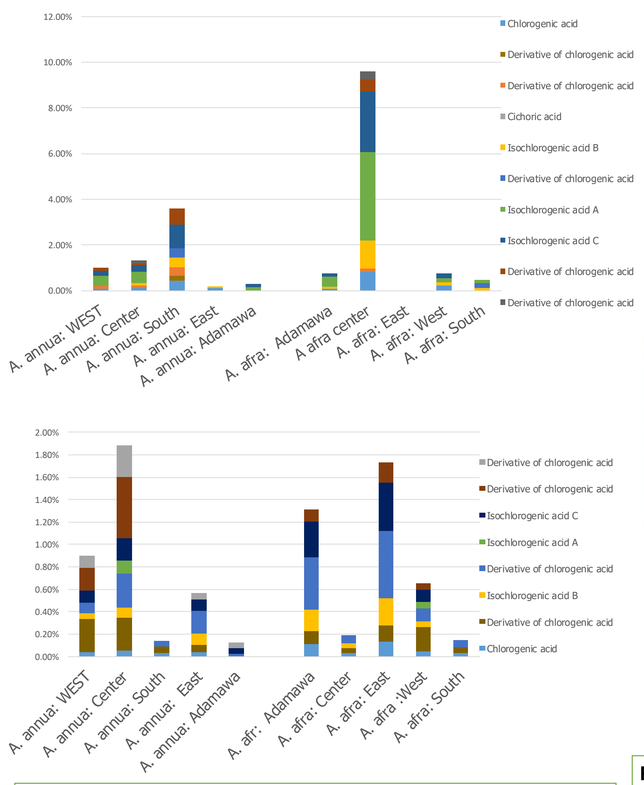


Figure 2: Chlorogenic acid content and its derivatives in *A. annua* and *A. Afra;* (top) samples collected in rainy season (bottom) samples collected in the dry season.

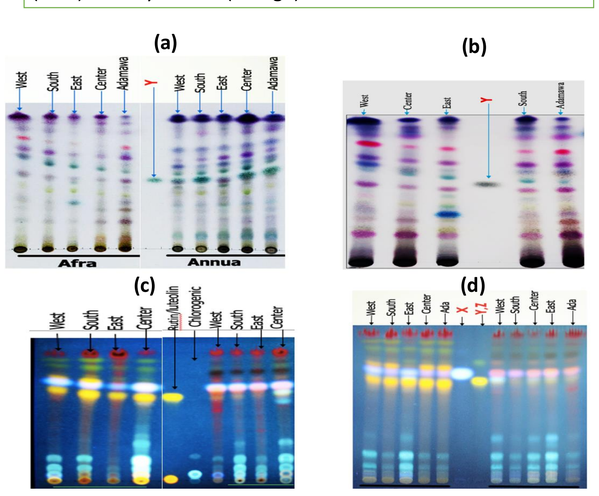


Figure 4: TLC fingerprint; **(a)** Acetone extract of both plants, **(b)** Acetone extract of *A. afra*, **(c)** polyphenol composition (methanol extract, rainy season samples) , **(d)** Methanol (dry season samples) X= scopoletin, Y= artemisinin and Z= apigenin.

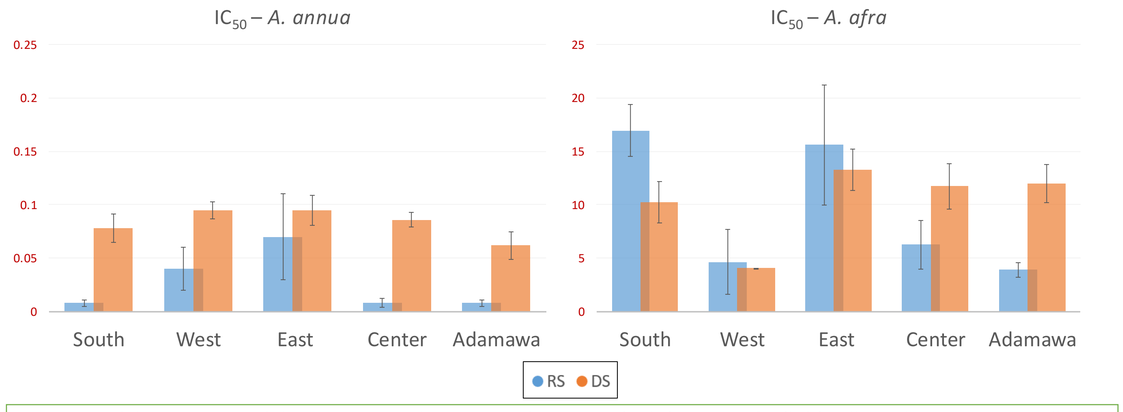


Figure 5: *P. falciparum* IC_{50} of the acetone crude extracts of *A. annua* (right) and *A. afra* (left) collected in rainy season (blue) and dry season (orange).

The polyphenol content of *A. annua* did not show a correlation with season or location. However, for *A. afra*, there was a slight increase in polyphenol content in the central region during the rainy season. Artemisinin content in *A. annua* tended to be higher during the rainy season, particularly in the central and Adamawa regions.

Artemisia annua demonstrates superior activity compared to *A. afra* with IC_{50} between 0,008 to 0,1 and 4,05 to 16,95, respectively, primarily attributed to its high artemisinin content, which is well-established. However, a consistent pattern reveals enhanced activity during the rainy season for *A. annua*, whereas the season does not seem to be an influencing factor for *A. afra.*

In the case of *A. annua*, the southern, central, and Adamawa regions exhibit the most noteworthy activity. Conversely, for *A. afra*, the western region (across both seasons), the central and Adamawa regions during the rainy season are particularly interesting in terms of activity.

Conclusions

Regarding *Artemisia annua*, collecting the plant during the rainy season when the vegetation is healthier appears to be relevant in terms of activity. This is likely linked to the presence of artemisinin. As for *Artemisia afra*, the factors investigated do not seem to correlate with its biological activity. This reinforces the hypothesis that the activity is not solely related to the artemisinin content it contains but rather to other constituents, such as the frequently mentioned guaianolides in the literature [4]. In terms of the Cameroonian region, it seems that East have the least vigorous vegetation, regardless of the season. Extracts from this region also exhibit lower activity. Therefore, analyzing the vigor of vegetation may be a relevant parameter for the selection of plants intended for prophylaxis and treatment purposes.

[1] Lahngong et al. (2023), doi: 10.3390/metabo13050613. [2] Climate data from Beck et al. (2018), doi:10.1038/sdata.2018.214. [3] Trager & Jensen. (1976), doi: 10.1126/science.781740. [4] Moyo et al. (2019), doi: 10.1186/s12936-019-2694-1.

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