Do Light Coloured Textiles Reduce Vector Mosquito Biting Pressure? A Simulated Field Study in Mali, West Africa.

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Background: What colour of clothing should one wear during a trip to the tropics?- The most effective way for travellers to avoid mosquito-borne diseases is to prevent mosquito bites. Personal protection methods include wearing long-sleeved clothing and protecting uncovered skin with insect repellents. These simple but effective methods are unanimously suggested by the national recommendations for travellers of several European countries for the prevention of malaria.

However, there is no agreement in these guidelines as to whether light-coloured clothing offers additional protection versus dark-coloured clothing.

Tested mosquitoes: *Aedes aegypti* is mainly biting at daytime and is known to transmit dengue, yellow fever, chikungunya, and Zika virus. *Culex pipiens* s.l. and the *Anopheles gambiae* s.l./ species complex are active at night. Both transmit filarial parasites, while *Culex* transmits the West Nile virus and anophelines malaria parasites.

Objectives: To assess the influence of black, white, and black/ white contrasted clothing on the rates of attraction exhibited by different species of vector mosquitoes under both diurnal and nocturnal conditions.

Fig.1 Metal frame with fabric cover (left) and the Mosquito Magnet Liberty Plus (right). The trap is combusting propane and releases CO_2, the strongest universal attractant for mosquitoes (1).

Materials and Methods: Simulated field tests conducted in Mali, West Africa, in a suburban setting close to Bamako. We used Mosquito Magnet (MM) traps as an alternative to human landing catches (2), along with textile covering targets in black, white, and black/white contrast. We decided to use mosquito-traps instead of human volunteers for this study for two reasons. Firstly, volunteers are at risk to contract diseases by mosquito bites, secondly, there is significant variation in the attractiveness of different individuals and their performance in catching mosquitoes trying to land on exposed body parts.

We therefore decided to use propane combustion traps which release CO_2 in combination with two chemical lures, that when combined, mimic human breath, drawing blood seeking female mosquitoes to the trap. The attractants used were: ATRAKTA®, a combination of lactic acid, octenol, and ammonium bicarbonate for *Aedes* and octenol only for *Culex* and *Anopheles*.

MM Traps were operated continuously for 24 hours for a period of 10 consecutive days, both during daylight and during nights with different moon phases (around full moon for light nights and new moon for dark nights). Catches were collected every hour and the traps with their targets were rotated clockwise daily to avoid areal bias. The trials took place from 5th to 14th Oct. 2022 (9th of Oct. full moon) and from 20th to 29th Oct. 2022 (25th of Oct. new moon). Traps were kept in a line, 8 meters apart, to allow mosquitoes to make a visual choice after they were attracted from long distances by the CO_2 and the lures.

Statistics: One Way Analysis of Variance (ANOVA) was performed to check for statistical differences in average daytime vs. nighttime catches, while paired student t-tests were used to check for significance between the differently coloured targets. Analysis was conducted using GraphPad Prism 9.00 for windows (GraphPad Software, La Jolla California, USA). Significance was taken at $p<0.05$.

Fig. 2 Experimental setup: MM traps with covers of black, contrasted and white fabric, mosquitoes pass the textile covers from below and the holes in the side, and get sucked into the trap.

Results:

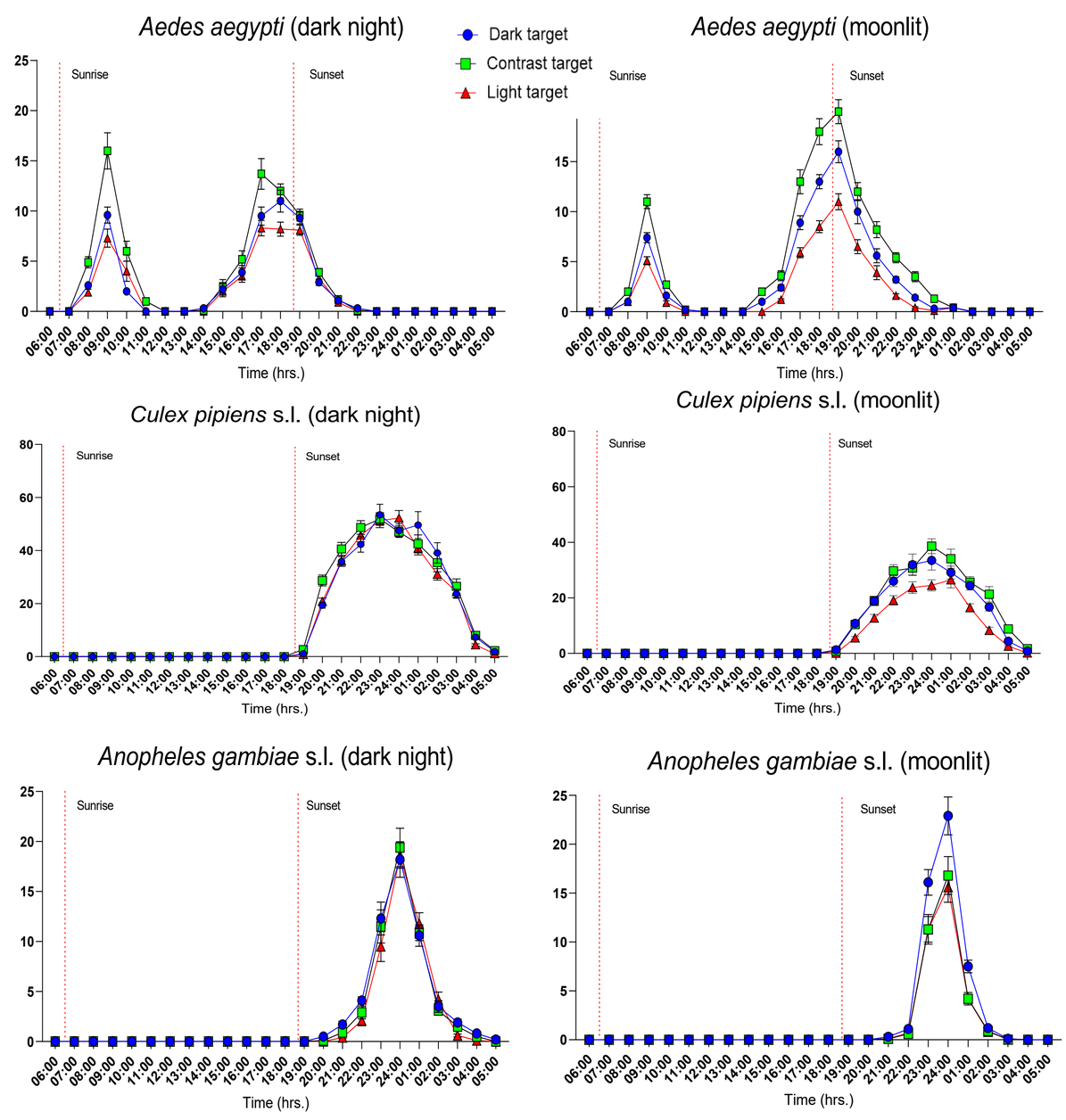
***Ae. aegypti*:** by one-way ANOVA, daytime catches of *Aedes* were significantly higher than night catches (df=2, n=1656; p< 0.0001). By paired t-test, during day and light nights, the black/white contrasted targets were significantly more attractive than the black (t=1.620, df=23; p=0.0466) and the white (t=2.599, df=23; p=0.0318), while black was significantly more attractive than white (t=1.620, df=23; p=0.0488). During dark nights, the contrasted and black targets attracted more mosquitoes than white targets, but the results were not significant (t=2.744, df=23; p=0.655).

***Cx. pipiens* s.l.:** hardly any *Cx. pipiens* s.l. specimens were collected during daytime. During light nights there was no significant difference between black and black/white contrasted targets (t=0.8571, df=23; p=0.070), but both attracted significantly more mosquitoes than white targets (t=2.136, df=23; p=0.0463 and t=0.8904, df=23; p= 0.0250). During dark nights the trend was the same, but results were not statistically significant (p>0.05).

***An. gambiae* s.l./ species complex:** during light nights the black targets attracted significantly more anophelines than contrasted (t=2.744, df=23; p=0.0116) and white targets (t=1.906, df=23; p=0.0419). There was no significant difference between contrasted and white targets (t=1.837, df=23; p=0.0605). In dark nights no preferences for the different coloured targets could be observed.

Molecular analysis of a subsample of 100 anophelines showed that during the trial *An. coluzzii* was the dominant species with 87%, with the remaining being *An. gambiae* s.s..

Average catches per hour of female mosquitoes with MM traps using three differently coloured targets: during daytime, dark and moonlit nights:



During the *Aedes* tests, white targets were approached up to 40% (157/ 392) less than black targets and up to 55% (287/ 522) less than contrasted traps during daytime hours. During the *Anopheles* tests, on moonlit nights, white targets were approached up to 34% (164/ 492) less than black, and in *Culex* tests, up to 30% (581/ 1979) less.

Conclusions: The results suggest that light-coloured clothing may significantly reduce mosquito biting rates during the day and during light nights. This effect may also be observed during dark nights if outdoor activities take place in illuminated areas. This is important information for travellers to areas with mosquito-borne infections, where it is the goal to minimize mosquito attractiveness.

Bibliography:

(1) Mosquito Magnet Operation Manual. Available from:
https://www.mosquitomagnet.com/support/help/patriot-plus
https://www.mosquitomagnet.com/mosquito-magnet-atrakta-attractant-catrak3n
https://www.mosquitomagnet.com/mosquito-magnet-octenol-attractants-coctenol

(2) Vezenegho SB. et al. Mosquito magnet liberty plus trap baited with octenol confirmed best candidate for Anopheles surveillance and proved promising in predicting risk of malaria transmission in French Guiana. Malar J. 2014;13:384.

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