Abstract

This research investigated the 35 kHz - 60 kHz frequency band of the naturally generated ultrasound of the African sheath tailed bat, Coleura afra , which elicited optimal evasive response in the African Anopheles gambiae. Recent study findings with the natural sounds of C. afra had shown ultrasonic components (35 kHz - 60 kHz) with capability to evoke avoidance response in the female A. gambiae s. s . Malaria whose vector are mated female A. gambiae is a health challenge in Africa and responsible for many deaths. Efforts to reverse the trend have shown low impact as manifested in the 2006 and 2008 World Health Organization statistics on Malaria. Curre ntly, the effective vector control measures include indoor residual spraying and the long - lasting insecticide - treated nets. Therefore there was need to critically investigate the 35 kHz - 60 kHz sound of C. afra with a view of exploiting it as an addition al vector control measure. The study therefore aimed at filtering the 35 kHz - 60 kHz frequency band, determine and analyse the acoustic transmission parameters of the sound of C. afra in the 35 kHz - 60 kHz frequency range; determine the activity and the behavioural response of the female A. gambiae to the ultrasound in the 35 kHz - 60 kHz frequency range. A set of ten 3 - 5 day old female A. gambiae bred and reared at the Kenya Medical Research Institute, Kenya were used in the bioassay study. The temperat ure and humidity was maintained at 25±2 o C and (60 - 80 %) respectively. The sound samples of C. afra were recorded using the Avisoft recorder from Kit - Mikayi caves, Kenya. The 35 - 60 kHz frequency band was filtered and analysed using the Avisoft SASLab Pro v ersion 5.1 and Raven Pro. version 1.4 software. The mosquitoes' behavioural response to the 35 - 60 kHz sound of C. afra and associated activities were observed and noted. It was established that the 35 - 60 kHz sound of C. afra consisted of 5046 calls of FM and CF modulated harmonics. The calls were generated through tongue clicks at the rate of 493.016 calls/minute. The calls were dominated by the short duration high frequency signals with an average acoustic energy of 9.2433 x 10 - 4 Pa 2 s which was lowest. The non - pulsate sound had a minimum and maximum amplitude of 71.21 Pa and 104.82 Pa respectively, with 2,519 calls between 90.00 - 99.00 Pa peak amplitude range. The signal power steadily declined with the increase in signal fr equency. Statistically, there was a highly significant relationship between the acoustic energy with the amplitude, frequency and bandwidth. The female A. gambiae assumed a normal posture with the body inclined at 45 o accompanied by occasional rubbed wings and legs under the bioassay control experiment. There was no remarkable change in physical behavioural activities in 60 % of the sample mosquitoes on exposure to the 35 - 60 kHz sound. Only 40 % exhibited immobility and excitation tendencies. At 95 % conf idence level, a paired T - test showed that the acoustic energy significantly affected the mean activities of the female A. gambiae ($p = 5.6477 \times 10 - 5$) with a low positive correlation. It was established that the mean mosquito activities under the influence of 35 - 60 kHz differed significantly from the mean activities under the control ($p = 0.008$). Only 30 % of the mosquito samples showed significant difference in the individual total mosquito activities under the influence of the 35 - 60 kHz sound of C. afr a and the individual total activities under the control. The mosquitoes recorded a mean rate of activities of 1.5598/minute when exposed to the 35 - 60 kHz sound of C. afra , 2.5195 times above the rate of activities at the control experiment. The rate of mosquito activities was significantly affected by the peak

amplitude, peak frequency and the bandwidth. The low significance in evasive response was attributed the non - pulsate nature of the sound of C. afra , declining signal power with increase in frequenc y, mixed sonar and social calls, and short duration high frequency calls. These results of this study give an insight into the reasons for low evasive response in female A. gambiae on exposure to the 35 - 60 kHz sound of C. afra . The acoustic transmission parameters of the sound required modifications in order to yield improved results. The improved results would provide Ultrasound as an addition malaria vector control measure which is locally available in Africa and hence cut down on mortality and economic burden resulting from Malaria.