MULTI-PRONGED SURVEY AND PROTOTYPICAL INFORMATION TECHNOLOGY APPLICATION AGAINST VECTOR-BORNE DISEASE IN NOAKHALI, BANGLADESH

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In this age of information technology where accesses to it are becoming cheaper by the day, especially by gadgets such as smartphones and cheap internet-access, it has promising scopes in interdisciplinary applications. In this paper, we aimed to probe how it can be used in the context of vector biology in a particular region of Bangladesh, which is a Least Developed Country according to the classification by the International Monetary fund. We carried out a multifaceted survey among volunteers who were from the region of Noakhali, which has considerable problems with mosquito-borne diseases. In the survey, we collected the data pertaining to basic knowledge of vector biology, awareness of methods to curb the said vectors and satisfaction with the eradication drives by the local government bodies there. Secondly, we also tried to gauge their awareness and familiarity with the basic tools of information technology and provided them with software which we had created to be used in follow-up studies. Some promising results were obtained which can pave the way for further progress in vector-borne disease eradication and more holistic lines.

1. INTRODUCTION

Vector-borne diseases plagued mankind since time immemorial. Perhaps the most immediate example of its fierce lethality in population scale comes from the history of Black Death, involving plague, in Europe, which killed an estimated 100-200 million people in the middle ages, with its vector being the rat flea. In

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modern times, although the said disease is very much controlled, vector borne diseases are still a significant percentage of all infectious disease, for which the World Health Organization puts a percentage of 17% among all infectious diseases, which caused a loss of staggering 400,000 deaths every year [1]. In some parts of the world, these vector-borne diseases, especially by mosquitoes, have reduced in number owing to better sanitation and personal protection. Still, we have a long way to go, as the continuously evolving vectors have not yet loosened their grip, or compelled to do so, in sum total. Evolving diseases are making the battle a much more complex, grim, and costly affair, as the statistics of a thirty-fold increase in worldwide incidence of Dengue, in the last thirty years, can attest to [2]. Mosquito-borne diseases such as Malaria, Dengue, Chikungunya, and Yellow Fever are still rampaging through, and ravaging across, vast swathes of the human population. Those affected, to exacerbate the situation, are often disproportionately affecting the poorer sections socioeconomically [3]. Considerable international and national efforts are being used to tame these vector borne diseases, and measures which are diversified and multidisciplinary are being introduced as the battle continues. Some of these, if we restrict ourselves to the strict scope of biology for the time being, includes initiatives which combine "entomologists, epidemiologists, molecular biologists, laboratorians, microbiologists, physicians, veterinarians, virologists, and zoologists", as in the case for the American Centers for Disease Control and Prevention's Division of Vector-Borne Diseases [4].

The pièce de résistance of the human species is hard to pinpoint but their society is undoubtedly one of its magnum opuses. It has made many progresses possible, not least of it being able to survive as group hunters and evolve out of Africa [5]. In modern times, its enormous magnitude is visible in endeavors such as the Human Genome Project [6], which would have had been almost impossible without international collaborations and tools that incorporate science and technological tools of the information age. With the advanced stage of science the human civilization is currently at, these sociobiological and technologically advanced tools should not be ignored in holistic studies in this domain. Many recent works in the field of vector biology have done just that. For example, the study about pupal persistence in urban and rural Kenya [7] has incorporated socio-demographic and environmental data along with the more traditional entomological surveillance. Usage of internet based communication tools along with detailed surveys and interviews, to give an example from a developed country, are being widely used to conduct vector

surveillance and control [8] in Florida. Many of these modern syntheses of methods are very new in many places of the world, as the studies about "knowledge, attitude and practices" about vector diseases in Australia shows [9]. In India and in Bangladesh, where our work is being down, such integrated approaches, especially those involving information technology and its awareness, are very rare or nonexistent.

Wherever and whenever researchers work with the stakeholders in the field of vector biology, due to the aforesaid mention of lower socio-economic standards of the human population that is affected along with it, there is a significant chance that additional factors will complicate the path towards the solution. Many skill-uptake initiatives which are often intertwined with the studies themselves should be broadened, the author opines, to make the stakeholders live a more fulfilled life as well as can make the applied research work more sustainable in the long run. We aimed to estimate the knowledge in these parameters related to vector-biology, the related eradication strategies in their homes and satisfaction with the community drives regarding eradication. Secondly, we aimed to find the knowledge of the volunteers about information technology, where three levels of awareness can be demarcated. One is the familiarity with *primarily* content-consumption devices (smartphones), the second is the familiarity with content-consumptive and content-creative devices while the third is the basic capability of computer programming, which is often more complex an activity than the preceding two.

2. METHODOLOGY

Study design: In our study, we included several variables which we will discuss later in this paper. Some of these were binary yes/no variables, whereas some variables had multiple possible choices from a set with or without the option of including a new one. Some variables were descriptive. Our study was an observational one with one interventional inclusion for a follow-up study. The work was mostly descriptive with some analytical components. Most of the items in the questionnaire survey were descriptive as it was a cross-sectional one, and the analytical parts include the word-frequency analysis from the descriptive text about mosquito habitats and the relationship between the levels of information-technological awareness. As for the directionality, our study design is retrospective, with the inclusion of a prospective element which is to be analyzed in a future study.

Sample and Inclusion Criteria: In this work, we undertook a survey using pen-and-paper and also by

Fig. 1. Satellite image of the interview location. The volunteers were from local and adjacent regions. The abundance of water bodies are readily visible in the region and its surroundings

digital means through one-by-one entry in a form. There was a subsequent period of discussion and two-way information exchange. A total of 92 volunteers participated, although not everyone did complete all the questions (it was not compulsory to do so). A semi-structured questionnaire was utilized and questions were encouraged in case of any confusion. In addition to the written survey for many participants, inputs were also taken digitally when the respondents preferred. All of the volunteers studied in equivalent Grade 12(end of high school) level, except one older volunteer. Responders in the paper also had their home addresses noted down, which was at or near Noakhali, for future contact in possible follow up studies. The location of the survey appearance was the Noakhali Gandhi Ashram(Latitude: 23°3'53.34"N, Longitude: 91°0'19.98"E) which is shown in the attached map. The survey was conducted in December 2019. The survey was conducted after the invited lecture by the author completed, which was about the legacy of Vidyasagar in mosquito eradication, where no specific details about the mosquitoes or their eradication techniques were disclosed keeping in mind the upcoming survey. The abundance of water bodies is highlighted as it is a salient feature of the

region, which among its many benefits also causes the disadvantage of a somewhat increased chance of breeding for mosquitoes.

The survey was not declared in advance to prevent their knowledge straying away from the baseline through academic and related preparations. The location was chosen for a number of reasons, which include:

1) The geography and economy of the region: Predominantly lying in an extensively flat and coastal land, the area is very well under the ambit of vector-borne disease control in the context of public health.

2) Governmental drives and initiatives were lacking in degree, perhaps due to the fundamental differences in economic indices such as per-capita GDP when compared to India. Here the survey possibly had a higher scope of contribution to useful results for proposed solutions.

3) The literacy rate of the district was less than 70% as per the official statistics [10] of 2011. Innovative and integrated approaches had a

higher scope of creating a chain-effect of pertinent education in the scope of vector-based disease eradication.

4) The participants were less homogeneous than what could be reasonably assumed to have happened in a private school or specific department of a college. Participants included students of diverse backgrounds and ages, all in or above high school.

5) The penetration of technological devices was also low compared to more saturated cities in India such as Kolkata. This enabled greater chances of using new technological devices such as smartphones as creative and scientific devices rather than majorly content-consumptive devices. This penetration, going by the trends, was likely to be continued for years to come. This could mean swifter avenues to success in the context of vector-borne disease eradication, especially when coupled with the fact that government help in this area was less than adequate.

6) The lesser penetration of research initiatives in the region compared to similar regions in India, such as West Bengal, made way for a better relationship among the variables of the research in their supposed cause and effect.

Description of the survey instrument, with interpretation type:

The survey consisted of the following questions which are translated(with minor added clarity, all of which were explained before taking the survey in person) from the attached picture with their question numbers matching. All questions were explained once verbally to the volunteers to prevent confusion. The questions were:

1. # Your age
2. Do you use smartphones?
3. Do you use computers, including laptops?
4. Do you know (computer) programming?
5. If you know programming, then which languages do you know?
6. Is your home area menaced by mosquitoes?
7. Do you use mosquito bed nets regularly?
8. Do the government take (visible) measures to reduce the menace of mosquitoes?
9. If yes, then what is the regularity for such eradication drives? [Options: <3 months interval/3-6 month interval/6-12 month interval/1-3 year interval/>3 year interval]
10. How important do you feel personal protection is when it relates to mosquito-bites? (has an

example)[Options:Very essential/essential/somewhat/not very much]
11. #Where do mosquitoes swarm? Where do they multiply themselves?
12. #Do mosquitoes lay eggs? (If yes,) where?
13. #Are mosquitoes of many types? How many? [The latter question has no right answer, but the sophistication of differentiating, such as between categories of genus or species, were sought]
14. #Mention some mosquito-borne diseases
15. #How many people worldwide are affected by mosquito-borne diseases[the missing term 'per year' was added verbally] per your estimate?
16. Do you close the doors and windows to protect yourself from mosquito bites?
17. #(If yes to the preceding question) when?
18. # (Tick) Do you use dhuna/mat/coil/others (with a blank) to eradicate mosquitoes?
19. How do those (personal protection measures) work?
20. Other remarks (Not used in the study).

The questions above which are marked with a '#' symbol denote the ones with a blank to be filled, which denotes a descriptive component. The bracketed terms are for clarity lost in literal translation.

The volunteers were handed out the survey sheets and the contents were explained subsequently so as not to cause any confusion and it was made clear that participation was voluntary and not all questions were mandatory. Some volunteers participated in digital entry one-by-one when that option was also given, using a laptop and spreadsheet software. Mutual discussions were explicitly prohibited verbally and it was made clear that there was no right answer or grading as in an academic test, and it was a survey testing individual knowledge. Any request for clarification or further discussion was adequately attended to. The discussions except for the basic context of the questionnaire were done after the volunteer had completed the survey. This ensured that the volunteers are not nudged towards more 'bookish' answers. Finally, we donated the pens provided to the young students, but it was not done *a priori*, to discourage volunteers from marking in haste for a reward, a situation not too uncommon among school students of that age. Consent for use in research was obtained from all subjects, as well as the hosting institution.

Part of the original questionnaire, in the local language of Bengali, is put as a figure. The remaining blank section was for general remarks.

Fig. 2. Part of a filled-in questionnaire without the general remarks section. The language is Bengali, which is the mother tongue of the volunteers

Descriptive data is provided as a whole. The analysis was performed on non-descriptive data by tallying the binary variables against one another. A lack of input on one binary variable was termed null and is not used in the numerical analyses as noted in the later sections of this paper.

3. RESULTS

The following results are predominantly put in percentages to avoid confusion. From the questionnaire, we can find a lot of interesting information regarding the current knowledge

available to the volunteers and how further knowledge can percolate through them and, to a lesser extent, in which form.

When it came to the accessibility of a smartphone or a computer, the economically disadvantaged nature of the volunteers was evident. Only about 60.87% reported using a smartphone of their own. At the end of 2019, it was quite a low figure. In the context of usage of smartphones, it was observed that the boys were using a smartphone of their own in a much higher percentage than the girls. For the case of using a computer in their household, only a paltry percentage of 17.39% reported positive. There was not much of a disparity between the sexes in this latter case. This was probably due to the fact that households usually include one or multiple male members who predominantly use the computer. Such specific distinction, however, was not made in the questionnaire.

In the context of at least a basic familiarity with computer programming languages, the results were not very encouraging for citizens of the information age. Only 26.08% of the volunteers reported some familiarity. This percentage was higher than the previous parameter probably due to some computer courses they learn at school or from some other secondary institutions.

The second question in this subtopic asked for what specific programming languages do the volunteers know. It was verbally made very clear that by 'knowing' we were only asking for a basic familiarity with the language. The answer to this question was not very encouraging. Only 8% of the volunteers wrote a positive response to this question. One answer was "HTML", which showed a lack of distinction between a programming language and a markup language. Even though we had a "C++" answer, another answer was "finding the LCM and HCF of two numbers". These pointed at a rather poor understanding in this field, as in standard courses the students do these exercises much before the end of their middle school, and almost all of the volunteers were in the final year of their high school.

Many of the next questions pertained to vector biology. The simple question, on mosquitoes being a portent in their local region, had an almost entirely positive response. 86.96% of the volunteers reported positively in this parameter. The second question was on the very common use of mosquito nets in that region, where 95.65% responded positively. Awareness of this very important and simple countermeasure was a relief for the author. On the question of the importance of personal protection to combat mosquito bites, the results were however mixed in outlook. Only 17.39% of the respondents thought that it was 'very essential'. An equivalent proportion thought it was merely 'essential', and 26% thought it was "more or less fine without but useful". Around 40% of the responders thought it was not important. The last parameter, no doubt, was a bit disheartening.

On the question of if they're personally aware that the government is involved in some anti-mosquito drives, a rather paltry percentage of 56.52% reported positive. More aids and drives are definitely required in this area.
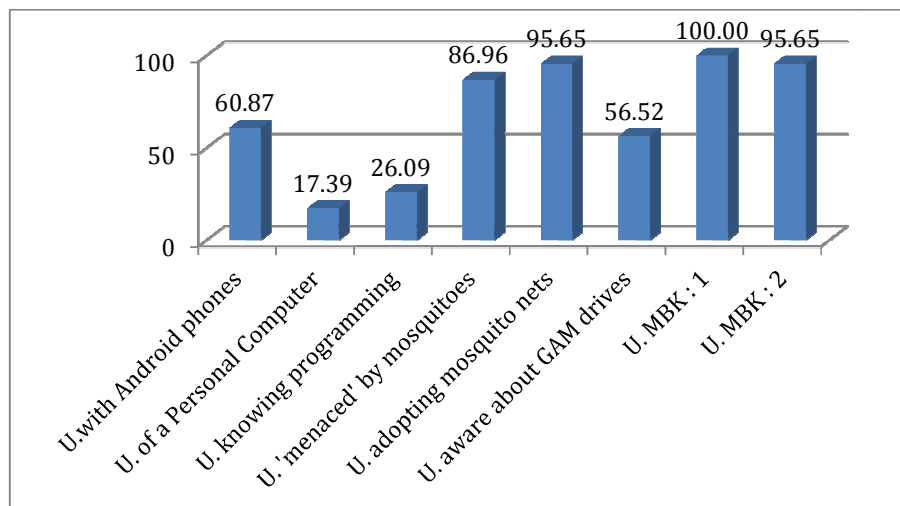

Fig. 3. Percentage of positive response on some objective parameters. U. =Users, GAM=Government (initiated) anti-mosquito, MBK= Mosquito-related basic question
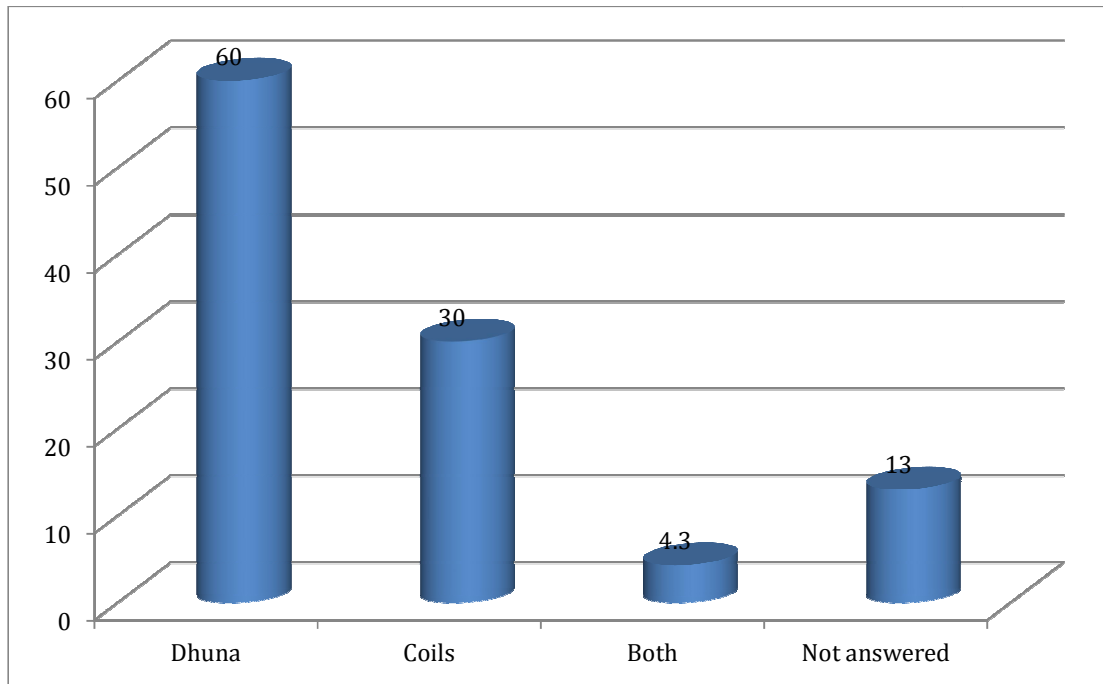
On the subjective questions involving a middle-school level knowledge of basic mosquito biology, the respondents illustrated an excellent grasp of the basics. 100% of the respondents, barring a very few who did not choose to answer the question, were aware of the existence of multiple genera of mosquitoes. Being asked to name up to five mosquito-borne diseases, Malaria and Dengue were topping the list, closely followed by Chikenguniya. Exotic diseases such as Yellow fever were not on the list.

On the subjective questions testing local awareness coupled with subject knowledge, the results were also fairly satisfactory. In both the open-ended questions of "Where do mosquitoes lay eggs?" and "Where do mosquitoes breed?", many intriguing responses were collected. Almost all of the respondents mentioned 'water' as the primary egg-laying ground of mosquitoes. The second most common word mentioned was garbage. The third common word, which did not have a very large frequency, was 'coconut shells'. The highly specific oddities such as 'cowdung' and 'flower vases filled with water' demand further inquiry. The lower end demarcation of 'at least 3-day old stagnant water' was perhaps a helpful mindset in tackling the mosquito menace, as artificially kept stray stagnant water can never be fully eliminated from households and near-households. The lower limit can put a compulsion on removing such stray water soon after their utility, if any, is extinguished.

In a difficult open-ended question which asks the volunteer to estimate how many people, worldwide, are afflicted by mosquito-borne diseases, the response rate was understandably low, with only 20% of the respondents choosing to answer it. The question also had a printing mistake, which was verbally corrected, with the word "per year" included in it. One bold attempt to answer it by writing "the majority" was clever but off the target, which was around 70 crore as of 2014 [11]. The other figures were also off the target as expected. This question was not aimed at the number per se, but the approach and justification, however, there were not many interesting bits in that which is worthy of presentation.

Coming back on the question of personal and near-family protection, the questions tried to gauge a few more important variables. In many regions of West Bengal, India, and Bangladesh, it is customary for the doors and windows to be closed during the evening to prevent the ingress of mosquitoes. If the volunteer did follow that custom, at what time slot did they do it? The time slots were divided into evening (5:30-6:30 PM), early evening (4:30-5:30 PM), afternoon (before 4:30) and late evening (after 6:30).

'Evening' was the most common answer, at 39% followed by 'afternoon' at 30.43%. Late evening was the least popular choice, and this agrees to the expectation of word of mouth, after some time in the evening, the ingress rate of mosquitoes in households is low. The final question in personal protection pertained to what kind of anti-mosquito chemicals the volunteers use at home to keep themselves and their families safe, and this had to options to choose from. In the personal experience of the author, 'mats'(mosquito-repellant) were a popular choice in the late 90s in India, after which they got replaced by 'coils' (mosquito-repellant cake with a coiled structure, which needs to be ignited) and more recently by electronic mosquito-repellent oils. The volunteers predominantly chose 'dhuna'(aromatic repallant smoke) as one of the important chemical release devices, with about 60% of the responders, including those who chose not to write anything in the 'others' category. Electronic vapor-releasing devices could have been put by checking 'others' and writing in a blank space, but nobody chose that option. Coils were also surprisingly popular, with about 30% of the volunteers choosing it, and some chose both of them (4.3%). About 13% of the volunteers chose not to answer the question, likely signifying they do not use any such products in their households.

Fig. 4. Visualization showing the frequency of most used words while describing mosquito egg-laying habitats. The larger and bolder the text, the more the frequency. These words are after literal translation from Bengali-English whenever that is required

Fig. 5. Chart showing the use of chemical release devices, among four choices, for those who answered. The percentages will not add up to 100

4. DISCUSSION

From our study, it was rather clear that *primarily* content-consumption devices, the smartphones, were being used by the majority of volunteers as a part of their regular life, and therefore information dissemination, and avenues of information uptake from them to a central database was possible for future projects. As about one-fifths of the volunteers reported using a computer, that avenue can also be used for a more community-oriented, as opposed to personally targeted information exchange avenues related to vector borne disease control and related themes. Usage of educational content through these channels, like was done earlier for more developed countries of USA and Mexico [12] therefore can be tried. The software we had developed in this theme previously was therefore provided to the volunteers, either by providing the Android-Package file to those who had smartphones with them or by providing the link to the same [13].

The volunteers were provided an updated version of the aforesaid software; the Bengali software application Mosa Domon ("Mosquito-Subjugation") in APK (Android Package) format, which is available online. This application had the capability of providing information about a few dominant species of mosquitoes. It also showcased the methods to eradicate them, as well as the signs of some infamous mosquito-borne diseases. Aimed at the younger audiences, the included mosquito-swatting game aimed to increase retention of the application and the deeper percolation of the information in the application among the users.

For users without a smartphone or access to one, a browser based HTML5 fork [14] of the application was also provided. Results from its usage will be an useful avenue of further progress in the field by follow up studies and distribution to more people.

The limitations of our study included the inability to apply more advanced software tools such as Android-based mosquito monitoring models such as those which were previously used in Indonesia [15]. The reason for this was the unknown technical capabilities of the volunteers before the survey and the time constraints for basic training in the same. This can be a viable avenue of further research as it can possibly bolster the fight against mosquito-borne diseases in the Least Developed Countries such as Bangladesh where government interventions were less with more budgetary constraints, where already existing smartphones in the hands of the users could have had reduced the hassle.

Fig. 6. Screenshots of the application Mosa-Domon, showcasing the included game, information about diseases, eradication methods, types of mosquitoes and the home-screen

In the context of existing knowledge in the volunteers which is not related to information technology directly, we also gathered some useful insights. From our study, it was quite clear that the volunteers had a reasonably strong grasp on the basic biology of mosquitoes that can be expected from an equivalent level of education in India. The second insight was that the volunteers had a keen interest in developing their skills further, both in the context of vector biology and in using the tools of technology fit in the information age. The third insight was that even though government initiatives were still quite lacking in the region, the volunteers had satisfactory hands-on knowledge about mosquito-borne diseases and on the use of specific personal and family protection measures. The avenue of further research in this context can be done by utilizing communication through social media and cross-sectional studies, along the lines done in countries such as Malaysia [16], as it was found that the basic knowledge about mosquito vectors was quite substantial to go along with the information-technology skills of the volunteers. This combination of skills by the volunteers paint a promising picture to follow up studies along the aforesaid lines which can be done with minimal training, such that the general public can act as working stakeholders to gather more inertia to the punch against the vector-borne diseases.

5. CONCLUSION

Although there is still a shortage of traditional technological tools like computers in the households of the volunteers, access to information technology tools such as smartphones was quite high in the volunteers and we can say that there is a strong possibility that these avenues can be utilized with more dominant effect in the context of vector biology in the near future. The confidence can be set high especially because both of these parameters are expected to grow in the future, as per global and country-specific trends [17], and because the baseline knowledge about vector-biology was commendable from our study in the specific region.

This initial study hints that a multidisciplinary approach in tackling mosquito-borne diseases in the specific and adjoining region is indeed possible. On one side, economies permitting, government initiatives and other related community measures can be further bolstered. On the other hand, usage of technological tools to further aid the young people to reduce the burden of vector-borne diseases, as well as empowering them with the lateral skills of analytical thinking, and a lot along those lines, can also be possibly done. In the broader goals of the project the authors are working on, that will be the next step.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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