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PREVENTION OF DENGUE THROUGH SAVING SKIN FROM MOSQUITO BITE

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Dengue in Bangladesh has been a nagging problem for the past few years with varying intensity over months. But sustainable control is yet far away. Rigorous attempts to control dengue have been limited to clean water hyacinths in ditches and ponds, stagnant water from flower pots, coconut shells, drains, tyres, etc. which are accumulated and encourage mosquito breeding.

It is an established fact that vector-borne diseases are better controlled by killing vectors. It is not known whether any research conducted to control mosquitoes in ponds, ditches, small or big water bodies, derelict ponds and changes in population density of mosquitoes in those areas. Obviously, population density will be more in ponds and other small or big water bodies than in flower pots on roof tops, tyres etc. Even if water hyacinth is cleaned, the larvae remain quite homely there.

Chemicals that kill larvae are called larvicides. Media reports say larvicide does not work. But the scientific reasons for failure have not been unearthed. The scientific reasons for failures have been discussed in two publications (Miah 2023, Miah 2024). According to WHO protocol, mosquito larvae are released in containers having different concentrations of larvicides. The larvae are surrounded by larvicides, and obviously they will die. These larvicides, when sprayed on larvae living above the ground, will be contaminated leading to mortality. But the biology of mosquitoes is different. They breed in water and larvae and pupae live under water, only they move to the water surface for breathing.

One aspect has been overlooked all the time because of the knowledge gap. Standing water in irrigated Boro rice field, which is clear, is a safe place for breeding of mosquitoes. Large scale adoption of the technique of Alternate

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Wetting and Drying (AWD) developed by International Rice Research Institute in water management is good enough to tackle this. The Department of Agricultural Extension under the Ministry of Agriculture is quite familiar with this technique.

The larvicide sprayed on water bodies cannot reach mosquito larvae living under water. The above two publications are based on 100 years old publication of works where soybean oil thinly poured in water created a thin oily film on water surface and caused suffocation to mosquito larvae and pupae. To implement that finding, simply soak sand or soil in soybean oil and throw those at random as sand balls over the whole water body. Larvae and pupae of mosquitoes, when coming up to water surface for oxygen uptake through their spiracles located at the tip of abdomen, cannot pierce through the oily film to inhale oxygen. As a result they die of asphyxiation (suffocation). Since oily film will disrupt surface tension of water, adult mosquitoes trying to land on water surface will have their legs dipped in water and be stuck to die (Miah 2023, Miah 2024).

Since available larvicides are ineffective, there is dire necessity to look for alternative larvicides. News media publicize prevalence and apprehend cause of mosquito population. But there is hardly any research or message on killing mosquitoes and protection of skin from mosquito bites under Bangladesh environment .In the prevailing circumstances, in addition to treatment in the hospital, a concerted effort is warranted at national level, community level in urban, periurban and rural level to control mosquito as well as to save skin from mosquito bite as preventive measures. These deserve a top priority attention to put dengue at bay. Simply hospitalization is not a sustainable strategy at all to get rid of dengue in the country.

This article elaborates different mechanisms to save skin from mosquito bite, for practicing at home and at community levels in urban, peri urban and rural areas which can be coordinated at national level.

A. Mosquito Magnet R, maker of CO2 recommended 30 ideas (Mosquito Magnet**)** to eliminate mosquitoes through various ways: a) Personal protection, b) Pet protection, c) Home protection, d) Yard protection, e) Community protection. Some of these relevant to Bangladesh socio-ecosystem are mentioned here.

Personal protection: 1) Use repellents- Mosquito repellent tablets like DEET is one option. In addition, several plants grown in Bangladesh work as good repellents,

like marigold, lavender, Tulsi, Mint, etc. The age-old system, now almost forgotten, is incense (dhup) smoke. Smoke of camphor is also a good repellent when used in the houses in the evening, keeping doors shut for some time. 2) Make simple diet changes, like eating more whole grain, fruits. Vegetables will make human being less attractive to mosquitoes. 3) Use mosquito repelling clothing- Special clothing may be made available which contain permethrin. This chemical is literally built in the fabric which repels mosquitoes. 4) Wear light coloured clothing which is less noticeable to mosquitoes. This also encourages less sweating and less smell. Sweat and smell are good attractants of mosquitoes. 5) Use extra mosquito protection like long sleeved shirts, full length pants and heavy weaved fabrics. With less exposed flesh, one will experience less bites.

Pet protection: Domestic animals are also good sources of blood for sucking specifically by female mosquitoes. So protect their skin using soybean oil smeared thinly over their body at regular interval. Camphor mixed with water if kept in animal sheds will repel mosquitoes.

Home protection: 1) Keep doors and windows closed particularly in the evening and morning when mosquitoes move to take shelter at day or night and stay longer. Using incense smoke in the evening will ensure better protection. 2) Run fans: Breeze from a fan can keep mosquitoes at bay. Oscillating fans can provide extra degree of difficulty to mosquito maneuverability. 3) Keep indoor humidity low. Air cooler is perfect for this. Moreover, it removes body odour and dries them out if they stay inside for too long.

Yard protection: Yard may inadvertently be a heaven for mosquitoes. Limit the number of breeding sites and protective cover that mosquitoes rely on, such as bush, jungles, and pits. Remove any water retaining material. 1) Invest in the mosquito traps as described later in this paper. 2) Eliminate standing water in containers where mosquitoes breed. It also includes puddles and ruts (a furrow or track in the ground) in the yard. 3) Put screens over rain barrels. Mosquitoes may also breed inside that barrel if not properly covered. A screen fastened over the rain barrel will block their access while serving as a debris filter. 4) Trim all grasses in the yard. Tall grass and thick vegetation provide protective cover and shades for mosquitoes during heat and light of the day. By eliminating these mosquito-friendly plants from the yard and premises, mosquitoes will keep away from the vicinity of dwelling houses. 5) Add

mosquito repelling plants in the yard like basil, mint, and lavender. Extracts of their leaves, if sprinkled inside the house will generate a type of pleasing smell which will also repel mosquitoes. Cracks in sanitary tanks also encourage mosquito breeding and spread in the vicinity.

Community protection: Mosquito is a menace, not for any individual, but for all members of the community as well. So involving the entire community is vital to address any common problem, communicate with all community members, neighbors, local organizations, municipality, mosques, local offices etc. 1) If standing water is noticed in the community, inform the appropriate authority to eliminate stagnant water or put soybean oil to create an oily film , which will kill larvae through suffocation. 2) Plant right trees around the shallow and stagnant water bodies which will absorb water in excess quantity, such as Eucalyptus, Avocado etc. 3) Support mosquito control efforts taken by public and private sectors. The Ministry of Health and Ministry of Local Government, Rural Development and Cooperatives may publicize mosquito control strategies in different areas. This simple communication can have a huge impact on future budgetary plans for mosquito control. Television channels can play a vital role through publicizing mosquito killing and skin protection strategies.

Protect domestic animals: Domestic animals like cows, goat sheep, and dogs are good hosts of mosquitoes for blood sucking. Smear light quantities of soybean oil or extracts of repellent plants over their bodies discussed above. Camphor can also be used.

Protect wild life: Protect wildlife that eat mosquitoes like frogs, birds, spiders, predatory insects, fish in ditches, ponds and other water bodies. Spraying larvicide leads to killing of many beneficial fauna like frogs, insects and spiders. Spraying larvicides will rather encourage mosquito population build up through killing their natural enemies. Share any mosquito control technique among people so that they know and can practice those wherever possible

B. Killing mosquito eggs, larva, pupa and adults with soybean oil: Soak sand or sandy soil in Soybean oil in a container. Scoop out this wet sand by hand and throw over the stagnant water, ponds, derelict pond, ditch etc. after cleaning those from water hyacinth and other floating weeds and debris. Oils from these sand or soil

will come out to spread over the water surface and will make an oily film to restrict access of oxygen to larvae and pupae to initiate asphyxiation (suffocation).

Mosquitoes lay eggs on substratum close to the water surface. Because of the process of adsorption, the imbibants (substratum) will allow imbibe (oil+water) to move upwards upto certain height of imbibants. So eggs will be in touch with oil, and egg chorion will be dissolved leading to failure of hatching. Thus the process will kill mosquitoes at all life stages.This phenomenon is similar to killing four birds with one stone.

Spray oil on the rooftop flower pots, coconut shells etc. and other junk areas where water may be accumulated and stored for mosquito breeding. Spraying on running water will be of no use.

C. Killing adults: A lesson can be learnt from Malaria Eradication Program implemented in fifties of last century, where mosquito, the vector was targeted using DDT in houses. DDT is no longer allowed for use; instead a long persisting insecticide needs to be developed for spraying in the houses. This approach is for killing adults. Adults can also be killed by sticky traps described later.

D. Protection of skin from mosquito bites: The traditional system of using mosquito nets while sleeping is one way of protecting skin from mosquito bite.But skin is exposed to mosquitoes for the rest of day and night outside the mosquito curtain. That time is enough for mosquito bites and disease transmission. Unless people are cautious, simply treating patients in the hospital, cleaning some water hyacinth, in water bodies, standing water of flower pots and air cooler, freezer etc. will never control dengue sustainably. However, few Do It Yourself (DIY) systems are suggested here.

E. Individual cum home approach: Apart from the community approach, some personal approaches are essential at individual level at home, both in towns and villages. The approaches are application of traps and repellents.

Traps: Trap is a known word for catching birds, rats, fish and other beneficial or harmful animals. Mosquito trap may seem to be unknown to many, because people are familiar with mosquito killing with pesticide, including mosquito coils and mosquito curtain for comfortable sleeping. Few trapping techniques are mentioned here as stated by Hensley (2023), Stewart (2024a, b).

Straw water technique

Materials needed and process: Bucket, water, straw, resin, castor oil. Place one handful of straw in a bucket and put water at the ratio 1:4. Allow this organic matter or straw for 3-4 days when the materials will be fermented producing a smell of carbon dioxide. This will work as attractants. Drain out this water after about a week. Larvae will die due to lack of water. While the fermented hay is at the bottom with water, the sides of the containers also need to be used as adult traps. Smear the sides with sticky glue which can also be made at home. Put 5 parts of resin into 8 parts of boiling castor oil and stir thoroughly. The glue will be ready.

When the attractant will invite adult mosquitoes they will land on the surface of the container also and will be stuck in the glue and die. Glycerin may also be used as another sticky material. These traps made in small containers should be placed in a few locations near and outside the windows and doors of the dwelling houses. The trap will remain effective for a month. It is better to replace the materials occasionally so that eggs laid there do not have time to hatch to perpetuate breeding.

Yeast and sugar technique: Making a combination of sugar, yeast and water is an effective way to trap mosquitoes in and around houses.After a few hours, the yeast starts releasing a steady stream of carbon dioxide, which mosquitoes are highly attracted to.

Materials needed and process: Empty plastic bottle, White sugar, yeast, water, black cloth or handkerchief. Cut off the top of an empty plastic bottle, cutting right below the neck. In the bottom of the bottle, mix together a sugar and yeast solution (if using a 2 liter bottle, mix 1 cup of warm water, 4 tablespoons (tbsp) of sugar, and 1/3 teaspoon of yeast; for a smaller bottle, use the same ratio and adjust the amount accordingly. Flip the top part of the bottle over so that it's pointed downwards and forms a funnel. Place it on top of the bottom part of the bottle. Use tape or glue to hold the funnel in place, making sure that any gaps or openings around the edges are sealed. Wrap the bottle in something black (leaving the top uncovered for mosquitoes to fly in) so that both the inside and outside are dark. Refill the trap with fresh yeast and sugar every few days. Place the device outside the houses in the afternoon.

Stagnant water technique: Mosquitoes are attracted to stagnant water if used correctly. Soaps and detergents are surfactants, which reduces the surface tension

of the water. When mosquitoes try to land on the surface of the water to lay their eggs, they won't be able to stay afloat and end up drowning. This is suitable for small areas around houses.

Keep in mind that this only works for certain mosquitoes. Only female mosquitoes that have already fed on blood will actively look for stagnant water to lay their eggs in. Make sure that stagnant water around the houses is eliminated. If it is to be installed inside the houses, kill the indoor mosquitoes or drive out with smoke or other repellents to be free from bite, because they will bite first before going into a trap.

Materials needed and process: Bucket or bowl, water and dish washing soap or liquid detergent. Fill a bowl or bucket with water.Add a few drops of soap or liquid detergent and mix gently, without making it too bubbly.

Sticky trap technique: During the day time, mosquitoes rest in the dark places of houses. This sticky trap does not attract mosquitoes *per se* rather arrests movement when they sit on the device. The device is a kind of sticky material which can be made at home. Take 8 parts of castor oil and boil. Put 5 parts of resin into the boiling oil and stir to make the sticky gum **(**Miah *et al*. 1984**)**. This gum is to be smeared on both sides of suitable size of cardboard/hard board/strong paper and hung in dark solitary places in the house. Glycerin can also serve as the sticky material. Mosquitoes resting on these sticky surfaces will not be able to escape.

Repellents: Repellents can function in two different ways: a) preventing mosquitoes from entering into the houses and b) preventing mosquitoes from coming in contact with the skin. Both ways will ensure skin safety from mosquito bites.

Homemade mosquito repellents rely on (Stewart 2024c) combination of essential oils mixed with a base of vinegar, witch hazel, coconut oil or isopropyl alcohol. One or several of the top 10 mosquito-repelling essential oils for maximum effect include: Eucalyptus, lavender, cinnamon, thyme, tea tree oil, rosemary, chamomile, peppermint, cedarwood and Citronella. These essential oils are found to be a mask for the odors that female mosquitoes are attuned to when searching for a blood meal. Sweat, body odor, CO2 and sometimes even blood type can emit smells that attract these blood suckers. Three Do It Yourself (DIY) mosquito repellent recipes are mentioned here.

1. Coconut Peppermint Mosquito Repellent: Materials needed and process: Coconut oil, Peppermint, Essential oil. To make it, mix 1/3 cup coconut oil and 15 drops of peppermint essential oil in a jar. At room temperature, the substance will be a liquid, but if it is stored in the refrigerator, it will solidify. It can be applied on the body with fingers on a hot day for a refreshing way to keep mosquitoes at bay.

2. Rosemary Mosquito Repellent: Materials needed and process: Rosemary oil, Apple cider, Vinegar, Water. Combine 1/4 cup apple cider vinegar, 1/4 cup water and 40 drops of rosemary oil in a spray bottle and shake well. If rosemary is not liked, lavender may be tried.

3. Eucalyptus Mosquito Repellent: Materials needed and process: Witch hazel, Eucalyptus oil, Water. For a "foolproof recipe" that banishes mosquitoes, combine 1/3 cup witch hazel and 1/3 cup water with 40 drops of eucalyptus essential oil. Mosquitoes detest the strong aroma of eucalyptus. On its own, witch hazel doesn't really have a scent, but lemongrass, citronella, or tea tree oil will work if eucalyptus is not preferred. Once the fragrance is gone, the repellency is gone.

Abrams (2023) suggested that 7 homemade repellents some of which are mentioned here.

1. Garlic water: Garlic is also a known mosquito repellent. Try whipping up a DIY spray by adding a few cloves of fresh, minced garlic to a tablespoon of mineral oil, then allowing it to sit and infuse for a day. Strain out the garlic, and then add it to a spray bottle of water. Spraying the garlic water mixture near all outdoor light sources will create a barrier that mosquitoes will not want to cross.

2. Coffee grounds: The internet recently discovered that mosquitoes hate the smell of coffee, so people have been sprinkling it all over their gardens and patios, or even burning it in a cup to see how well it works. The caffeinated beverage actually repels multiple types of insects, making it an ideal choice for outdoor parties of any size.

3. Incense: Burning certain types of incense or candles can also help repel mosquitoes. Citronella and lemongrass are both known for their insect-repelling properties. Burn them in and around home to create a natural barrier against mosquitoes. Some plant derivatives known as incense in Bangladesh were used in dwelling houses in the past. This also works when applied in the evening.

4. Essential oils: Adding a few drops of pungent oils like thyme, lavender or peppermint to a spray bottle filled with water, then spraying it around kitchen and mosquito-ridden outdoor spaces to repel mosquitoes.

Process of making some homemade mosquito repellents (Kinney 2024) out of 17 are described here-

1. Lemon Eucalyptus Oil: Lemon eucalyptus essential oil is derived from a plant that contains citronella oil and p-mnthane 3,8-diol. The property which makes this chemical compound effective is the p-methane, which is very useful as a DIY mosquito repellent.

Materials needed and process: 2 teaspoons lemon eucalyptus oil, 3 ounces of witch hazel, Spray bottle.

Add witch hazel and lemon eucalyptus oil to the spray bottle and combine. Store this spray in a dark and dry place. Typically, this mixture lasts a few weeks. Apply the solution as needed directly onto the skin. However, do a test patch first.

2. Cinnamon Oil Recipe: Cinnamon is a powerful herb that is extracted from cinnamon bark. It has been known to be effective in repelling mosquitoes and similar insects.

Materials needed and process: 2 teaspoons cinnamon extract, 2 ounces of water, Spray bottle. Pour water in the spray bottle. Add cinnamon extract. Shake the bottle a few times until the mixture is thoroughly combined. Spray the solution onto your body before leaving the house and reapply as needed.

3. Lemongrass and Rosemary oil: Limonene and citronella are components that are found within lemongrass and are used to repel mosquitoes. Rosemary essential oil has strong properties of eucalyptol as well, making it useful repellent.

Materials Needed and process: 10 drops rosemary oil, 10 drops lemongrass oil,4 ounces jojoba oil,Spray bottle. Pour rosemary and lemongrass oil into a squeeze bottle. Add the jojoba oil and mix until all three oils are combined. Shake the bottle multiple times before applying it to the skin.

4. Tea tree oil: Tea tree oil has numerous benefits and is best known for being anti-microbial. Typically, it is used as a topical, but others use it as an antiseptic or anti-

inflammatory remedy. These properties enable it to soothe and repair itchy bumps while also preventing insects from biting.

Materials needed and process: 8 drops tea tree oil, 4 ounces coconut oil or olive oil, squeeze bottle .Combine tea tree oil and coconut oil or olive oil. Mix them until they are combined and then apply this multiple times throughout the day.

5. Lavender oil, Vanilla and Lemon insect repellent: Lavender oil, vanilla and lemon each has properties that repel mosquitoes. Limonene, eucalyptol and camphor can all be found in lavender oil and are effective at keeping bugs away. The citrus in lemon also has a high acid content, which prevents them from biting skin.

Materials needed and process: 10 drops of lavender essential oil, 3 tbsp. vanilla extract, 3 tbsp. fresh lemon juice,1 cup of water and Spray bottle. Mix lavender oil with vanilla extract in a spray bottle. Add in the freshly squeezed lemon juice before finally adding water. Shake the bottle continuously until the ingredients are combined. This can be sprayed on the skin two to three times a day.

6. Neem and Coconut oil: A small amount of neem oil is an effective mosquito repellent that can be used in multiple ways. Mixing neem oil with coconut oil will help ensure that it doesn't damage the skin and prevents further mosquito bites. Furthermore, neem oil ensures that no toxic chemical is put onto the body that may damage skin. Neem oil makes a great DIY mosquito repellent spray for the yard. These materials are easily available in Bangladesh.

Materials needed and process: 20 drops neem oil, 2 ounces of coconut oil, spray bottle. Place neem oil into a squeeze bottle. Mix it well with coconut oil before applying it to the skin.

7. Apple Cider Vinegar: Apple cider vinegar itself is not a repellent, but mixing it with essential oils can help. Combine with peppermint, lavender or cinnamon oil for a homemade insect repellent. The apple cider vinegar will raise the pH levels of skin, causing mosquitoes to fly in the other direction.

Materials needed and process: 2 ounces apple cider vinegar, 1/2 cup of water,10 drops peppermint oil and a bottle with pump. Pour apple cider vinegar into a bottle. Add water before adding peppermint oil. Once all these three are combined, shake

the solution until it's mixed. Shake it every time before using it as the oil may separate from the other ingredients. Apply it to the skin before leaving the house.

Onion cup method (Google/Facebook): This is a simple homemade repellent made of materials easily available in markets and villages.

Materials needed and process: Onion, Naphthalene, mustard oil, leaves of neem and mint, tissue paper. Take a big onion. Cut the top and bottom slightly to give it a shape of a cup by scooping the flesh from one side. Put ground naphthalene in the cup and pour mustard oil in the cup. Then take a piece of tissue paper and put neem and mint leaves on it and make a roll, put two ends of the roll in such a manner that the two tips will form a wick. Insert this roll in the onion cup with the wick on top. Drench the tissue paper roll thoroughly with mustard oil. Set fire on the wick. The combined smell of neem, naphthalene, mint and mustard oil will drive out mosquitoes. Keep it burned for a few minutes every day in the evening. After fire is put off, the smoke generated will further work for some time as repellent.

CONCLUSION

In view of failure to control dengue, it is now the time to think of an integrated approach to control dengue, not just providing medical services in hospitals. There are four components of integrated approach: a) Treatment of patients in hospitals after infection, b) Killing of mosquitoes at their different life stages, c) Saving skin from mosquito bites since one mosquito is enough for transmission d) Prevent breeding in stagnant water in irrigated Boro rice field. Therefore, it is necessary to launch a nation-wide "Dengue Eradication Program" for which a strategic plan needs to be formulated. Few technical committees to handle above a,b,c and d components of integration will need to be formed with relevant experienced scientists. The functions indicated as "a" will be handled by Hospitals and the Ministry of Health. Components "b" will be operated by City Corporations "c" will be handled by the Ministry of Local Government Rural Development & Cooperatives, "d" will be coordinated by Department of Agricultural Extension under Ministry of Agriculture.

City Corporation will administer soybean oil over all areas having stagnant water. Participation of local people will have to be ensured. There will be some selected people to administer crude soybean oil. Refined and consumable oil may

be pilferage which can be stopped by putting a few drops of kerosene oil in soybean oil before delivery to the end point. They will be supplied with crude soybean oil, sand, pieces of cloth or unusable tissue paper or newspaper. Sand will have to be soaked in soybean oil. Then scoop out sand with hand which has to be thrown at random at different places of water bodies. Sand may also be wrapped with tissue paper for throwing to a long distance .The selected people may be paid some service charge as honorarium and City Corporation will monitor the performance. For rural areas, Union Parishad can be assigned with the tasks of soybean oil application and training on homemade mosquito traps and repellents. Upazila Health workers may be assigned for monitoring the efforts.

Electronic and print media will need to publicize the techniques regularly as part of Dengue Eradication Program. Additionally plenty of leaflets containing the process of making traps and repellents at home will be distributed by Sub-Assistant Agriculture Officers (SAAO) of Department Agricultural Extension who are working in village level.

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