

Aug 12, 2024

## Design and validation of a low-cost sugar-feeder for resource-poor insectaries.

DOI

[dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1](https://dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1)



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DOI: [dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1](https://dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1)

**Protocol Citation:** Zachary Thomas Stavrou - Dowd, Clair Rose, Alvaro Acosta Serrano, Lee R Haines 2024. Design and validation of a low-cost sugar-feeder for resource-poor insectaries.. [protocols.io https://dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1](https://dx.doi.org/10.17504/protocols.io.14egnzrbmg5d/v1)

**Manuscript citation:**

Stavrou-Dowd et al., 2024. Design and validation of a low-cost sugar-feeder for resource-poor insectaries.

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**Protocol status:** Working

**We use this protocol and it's working**

**Created:** June 11, 2021

**Last Modified:** August 12, 2024

**Protocol Integer ID:** 50699

**Keywords:** ATSB, Malaria, Sugar Feeding, Anopheles, Mosquito, Vector Control, Sugar Baits, viable dyes

**Funders Acknowledgement:****Bill & Melinda Gates****Foundation**

Grant ID: INV-022192

**Jean Clayton Fund - Liverpool****School of Tropical Medicine**

Grant ID: JC0621CR02

## Abstract

### Background

The emergence of insecticide resistance in insects has led researchers to develop new control tools so that historic gains made in reducing disease transmission are not lost. Attractive targeted sugar baits (ATSBs) are a vector control tool being widely trialled to target insects that feed on plant sugars and blood. We designed a field-friendly, economical and more environmentally responsible sugar feeder for maintaining mosquito colonies and screening potential ATSB candidates.

### Methods

We simultaneously tested, in both male and female *Anopheles gambiae* mosquitoes, the effect of adding three water-soluble medical and food dyes (Allura Red, fluorescein and tartrazine) to the sugar solution to identify those insects that had ingested sugar from the feeder. To test feeder efficacy to deliver a toxic substance, we assessed the killing using boric acid, which kills both male and female mosquitoes when ingested. Using microscopy techniques compatible with fieldwork, including the use of a mobile phone camera, we documented the efficacy and tissue specificity of the dyes on mosquitoes after they were continuously fed dyed sugar solutions.

### Results

The easy-to-construct sugar feeder is an economical option for testing the efficacy of ATSB components on *Anopheles gambiae* mosquitoes. Allura Red AC was the preferred dye as it has low toxicity to mosquitoes and allows the researcher to quickly visualise the imbibed sugar meal within the abdomen. Feeding 1% fluorescein dye, but not 0.1%, for longer than five days induced systemic dye distribution, where the mosquito's wing veins, antennae and legs brightly fluoresced when examined by a handheld black light torch (395-400nm emission).

### Discussion

Developing an affordable sugar feeder to maintain insectary-reared insects and test the efficacy of ATSB candidates involves designing a dye-labelled sugar bait station that is of low-toxicity, reusable and easy to construct using components available in low resource settings such as field stations.

## Image Attribution

Lee R. Haines

## Materials

Suppliers are those used within the study. Please use alternative supplier if required.

### Sugar Feeder Construction

Equipment	
<b>Surgical Tape</b>	NAME
Masking Tape	TYPE
3M	BRAND
None	SKU
<a href="https://www.amazon.co.uk/Micropore-Surgical-Tape-White-1-25cm/dp/B0009Q01E0">https://www.amazon.co.uk/Micropore-Surgical-Tape-White-1-25cm/dp/B0009Q01E0</a> <sup>LINK</sup>	

Equipment	
<b>Rubber Band</b>	NAME
Rubber Band	TYPE
Rubber Band	BRAND
9340007	SKU
<a href="https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/rubber-bands/size-33-rubber-bands-pk-454g-9340007/">https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/rubber-bands/size-33-rubber-bands-pk-454g-9340007/</a>	
Size 33 87 x 2mm	SPECIFICATIONS

## Equipment

Paper Clip	NAME
Paper Clip	TYPE
Paper Clip	BRAND
567-8618	SKU
<a href="https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/paper-clips/paperclips-plain-51mm-pk1000-33281/">https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/paper-clips/paperclips-plain-51mm-pk1000-33281/</a>	LI NK
Plain 51mm	SPECIFICATIONS

## Equipment

Tights	NAME
Tights	TYPE
Tights	BRAND
None	SKU
<a href="https://direct.asda.com/george/women/socks-tights/brown-sheer-15-denier-tights-5-pack/GEM747177,default,pd.html?cgid=D1M1G20C14&amp;placement_id=item_page.pdp1&amp;strategy=bab_v2&amp;config_id=item_page.pdp1&amp;parent_item_id=GEM831629&amp;product_id=GEM747177&amp;slotClicked=">https://direct.asda.com/george/women/socks-tights/brown-sheer-15-denier-tights-5-pack/GEM747177,default,pd.html?cgid=D1M1G20C14&amp;placement_id=item_page.pdp1&amp;strategy=bab_v2&amp;config_id=item_page.pdp1&amp;parent_item_id=GEM831629&amp;product_id=GEM747177&amp;slotClicked=</a>	LI NK
15 Denier	SPECIFICATIONS

## Equipment

**Glass Bijou** NAME

Tube TYPE

Murray and Co Ltd BRAND

215-3568 SKU

<https://uk.vwr.com/store/product/18618073/bottles-glass-bijou-type-sterilin> LINK

7ml SPECIFICATIONS

## Equipment

**7.0 ml Polystyrene Bijou Container** NAME

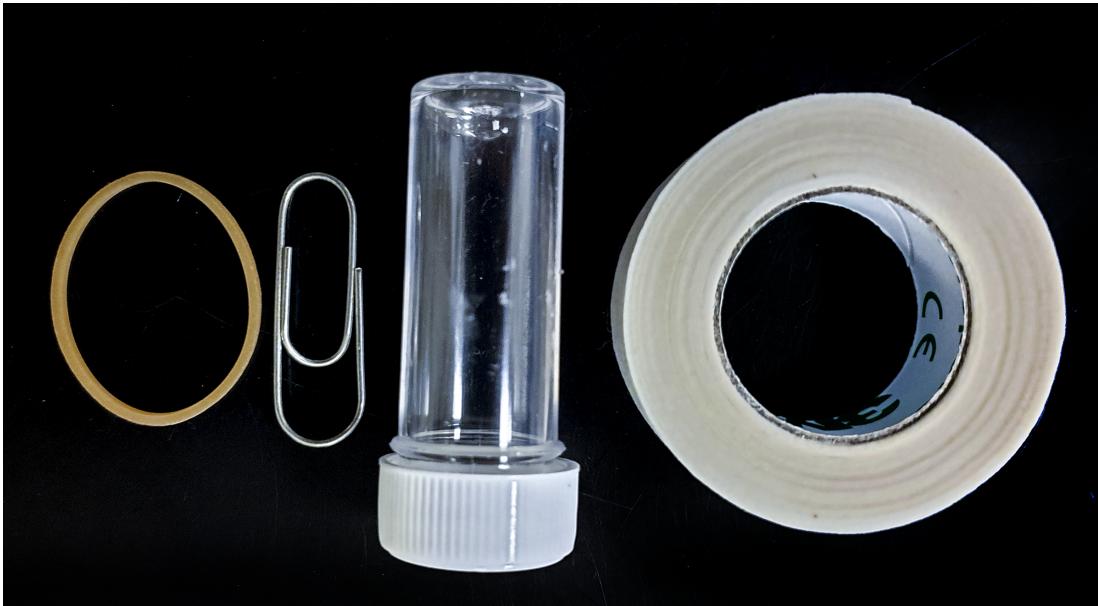
Tube TYPE

StarLab BRAND

E1412-0711 SKU

<https://www.starlabgroup.com/GB-en/product/7.0-ml-bijou-containers-sterile-pf-sl-155250.html> LINK

50 mm high x 23 mm diameter (including cap) SPECIFICATIONS



A	B	C	D	E	F	G
Material	£ Cost/package	# items /package or amount of package estimated for a single feeder (tights and tape)	£ cost/item	Link	Cat number	Company
Glass bijou (7ml, Murray and Co Ltd)	33.50	245	0.1367	<a href="https://uk.vwr.com/store/product/18618073/bottles-glass-bijou-type-sterilin">https://uk.vwr.com/store/product/18618073/bottles-glass-bijou-type-sterilin</a>	215-3568	VWR
Plastic bijou (7 ml polystyrene screw cap)	98.00	700	0.1400	<a href="https://www.alphalabs.co.uk/129202">https://www.alphalabs.co.uk/129202</a>	129202	Alpha
Rubber band (Size 33 87 x 2mm)	1.98	875	0.0023	<a href="https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/rubber-bands/size-33-rubber-bands-pk454g-9340007/">https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/rubber-bands/size-33-rubber-bands-pk454g-9340007/</a>	9340007	Staples
Paper clip (Plain 51mm)	12.26	1000	0.0123	<a href="https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/paper-clips/paperclips-plain-51mm-pk1000-33281/">https://www.staples.co.uk/office-supplies-and-stationery/office-basics-and-stationery/office-clips-and-fasteners/paper-clips/paperclips-plain-51mm-pk1000-33281/</a>	567-8618	Staples
Tights (15 denier)	2.50	500	0.0050	<a href="https://direct.asda.com/george/women/socks-tights/brown-she">https://direct.asda.com/george/women/socks-tights/brown-she</a>	none	Asda

A	B	C	D	E	F	G
				er-15-denier-tights-5-pack/GEM747177,default,pd.html?cgid=D1M1G20C14&placement_id=item_page.pdp1&strategy=bab_v2&config_id=item_page.pdp1&parent_item_id=GEM831629&product_id=GEM747177&slotClicked=1		
Tape (3M surgical tape, Micropore)	9.29	240	0.0387	<a href="https://www.amazon.co.uk/Micropore-Surgical-Tape-White-1-25-cm/dp/B0009Q01EO">https://www.amazon.co.uk/Micropore-Surgical-Tape-White-1-25-cm/dp/B0009Q01EO</a>	none	Amazon
	Cost per feeder					
Glass	0.1950					
Plastic	0.1982					
*glass or plastic costs the same - £0.20						

## Dyes used for detection of sugar feeding

1.  Allura Red AC Sigma – Aldrich Catalog #458848-100G
2.  Tartrazine Alfa Aesar Catalog #A17682
3.  Fluorescein Sodium Salt Honeywell Fluka Catalog #28803

## Safety warnings

- ❗ When using dyes follow manufacturers SDS and local and national guidelines.

## Before start

Watch video of method

1



- 2 Collect materials required for construction of feeder. See "Materials"

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#### STEP CASE

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##### Field Friendly Sugar Feeder 7 steps

This sugar feeder is designed for field work conditions when resources are limited. It does not require access to any power tools and is set up using only five components.

- 3 Using either your hands or a pair of pliers, unravel the outer loop of a paperclip and twist it into a hanger.



- 4 Mould the outer loop around the **bottom** of the tube and leave the inner loop free to construct hanging hook



- 5 Tape down the paperclip around the tube using masking tape - 2 or 3 wraps is sufficient. If hanging outdoors, use waterproof tape.



- 6 Invert the feeder so the hook is now pointing to the floor and fill feeder with sugar solution. Adding an insect-safe dye allows sugar levels to be easily monitored.
- 7 Place a square of fabric tautly over the opening of the feeder and secure in place with an elastic band. **Ensure the fabric used has been previously washed** to avoid exposure to insecticides commonly sprayed on textiles during shipment and storage.
- 8 With thumb placed on top of fabric (to prevent fluid leakage) quickly but gently rotate feeder 180° so hanger is now top positioned.
- 9 Hang the sugar feeder inside a cage or wherever testing may be taking place