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# PermaNet® portfolio: innovation & partnerships

IVCC stakeholder forum  
Liverpool, UK

October 2023



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- 1 PermaNet® portfolio
  - 2 Innovation & partnerships
    - Product development
    - Manufacturing scale up
    - Insecticide resistance management and other strategic areas

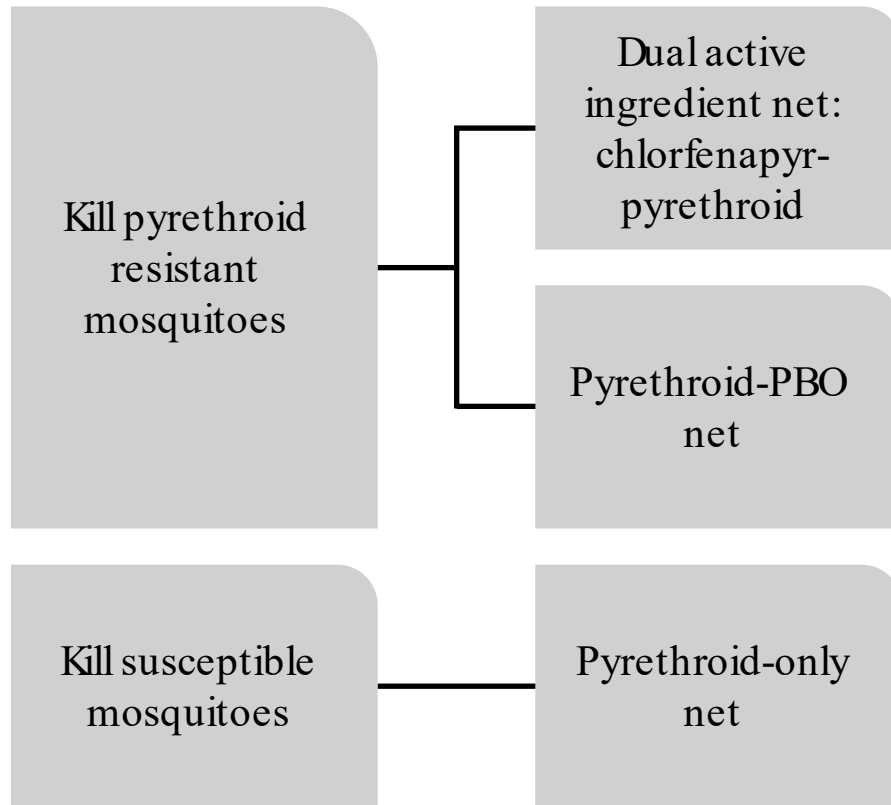






# Three distinct segments

WHO  
insecticide  
treated net  
classes\*



# Three distinct products

PermaNet®  
Dual by VESTERGAARD



PermaNet®  
3.0 by VESTERGAARD






PermaNet®  
2.0 by VESTERGAARD



\*WHO (2021). Insecticide-treated nets for malaria transmission control in areas with insecticide-resistant mosquito populations Preferred product characteristics <https://www.who.int/publications/i/item/9789240018730>



# PermaNet® product portfolio

Killing pyrethroid susceptible mosquitoes	Killing pyrethroid resistant mosquitoes	Killing pyrethroid resistant mosquitoes	
<p>Pyrethroid-only 1<sup>st</sup> generation</p> <p><b>PermaNet®2.0</b> deltamethrin</p>	<p>Pyrethroid-PBO 2<sup>nd</sup> generation</p> <p><b>PermaNet®3.0</b> deltamethrin – PBO</p>	<p>Dual AI (+ pyrethroid) 3<sup>rd</sup> generation</p> <p><b>PermaNet®Dual</b> chlorfenapyr – deltamethrin</p>	<p>Dual AI (+/- pyrethroid) 3<sup>rd</sup> /4<sup>th</sup> generation</p> <p><i>Additional product with different AI (MoA) for IRM</i></p>
<p><b>PermaNet®</b>  2.0 by VESTERGAARD</p>	<p><b>PermaNet®</b>  3.0 by VESTERGAARD</p>	<p><b>PermaNet®</b>  Dual by VESTERGAARD</p> <p><b>Insecticide Resistance Management (IRM)</b></p> <ul style="list-style-type: none"> <li>• Rotation? Mosaic?</li> </ul>	

RESEARCH

Open Access

# Small-scale field evaluation of PermaNet® Dual (a long-lasting net coated with a mixture of chlorfenapyr and deltamethrin) against pyrethroid-resistant *Anopheles gambiae* mosquitoes from Tiassalé, Côte d'Ivoire



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## Abstract

**Background** Due to the rapid expansion of pyrethroid-resistance in malaria vectors in Africa, Global Plan for Insecticide Resistance Management (GPIRM) has recommended the development of long-lasting insecticidal nets (LLINs), containing insecticide mixtures of active ingredients with different modes of action to mitigate resistance and improve LLIN efficacy. This good laboratory practice (GLP) study evaluated the efficacy of the chlorfenapyr and deltamethrin-coated PermaNet® Dual, in comparison with the deltamethrin and synergist piperonyl butoxide (PBO)-treated PermaNet® 3.0 and the deltamethrin-coated PermaNet® 2.0, against wild free-flying pyrethroid-resistant *Anopheles gambiae* sensu lato (*s.l.*), in experimental huts in Tiassalé, Côte d'Ivoire (West Africa).

**Methods** PermaNet® Dual, PermaNet® 3.0 and PermaNet® 2.0, unwashed and washed (20 washes), were tested against free-flying pyrethroid-resistant *An. gambiae s.l.* in the experimental huts in Tiassalé, Côte d'Ivoire from March to August 2020. Complementary laboratory cone bioassays (daytime and 3-min exposure) and tunnel tests (nightly and 15-h exposure) were performed against pyrethroid-susceptible *An. gambiae* sensu stricto (*s.s.*) (Kisumu strain) and pyrethroid-resistant *An. gambiae s.l.* (Tiassalé strain).

**Results** PermaNet® Dual demonstrated significantly improved efficacy, compared to PermaNet® 3.0 and PermaNet® 2.0, against the pyrethroid-resistant *An. gambiae s.l.* Indeed, the experimental hut trial data showed that the mortality and blood-feeding inhibition in the wild pyrethroid-resistant *An. gambiae s.l.* were overall significantly higher with PermaNet® Dual compared with PermaNet® 3.0 and PermaNet® 2.0, for both unwashed and washed samples. The mortality with unwashed and washed samples were  $93.6 \pm 0.2\%$  and  $83.2 \pm 0.9\%$  for PermaNet® Dual,  $37.5 \pm 2.9\%$  and  $14.4 \pm 3.9\%$  for PermaNet® 3.0, and  $7.4 \pm 5.1\%$  and  $11.7 \pm 3.4\%$  for PermaNet® 2.0, respectively. Moreover, unwashed and washed samples produced the respective percentage blood-feeding inhibition of  $41.4 \pm 6.9\%$  and  $43.7 \pm 4.8\%$  with PermaNet® Dual,  $51.0 \pm 5.7\%$  and  $9.8 \pm 3.6\%$  with PermaNet® 3.0, and  $12.8 \pm 4.3\%$  and  $-13.0 \pm 3.6\%$  with PermaNet® 2.0. Overall, PermaNet® Dual also induced higher or similar deterrence, exophily and personal protection when compared with the standard PermaNet® 3.0 and PermaNet® 2.0 reference nets, with both unwashed and

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# scientific reports



## OPEN PermaNet Dual, a new deltamethrin-chlorfenapyr mixture net, shows improved efficacy against pyrethroid-resistant *Anopheles gambiae* sensu lato in southern Benin

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Pyrethroid-chlorfenapyr nets have demonstrated improved entomological and epidemiological impact in trials across Africa. This is driving increased demand for this novel net class in malaria-endemic countries. PermaNet Dual is a new deltamethrin-chlorfenapyr net developed by Vestergaard Sàrl to provide more options to malaria control programmes. We performed an experimental hut trial to evaluate the efficacy of PermaNet Dual against wild, free-flying pyrethroid-resistant *Anopheles gambiae* sensu lato in Cové, Benin. PermaNet Dual induced superior levels of mosquito mortality compared to a pyrethroid-only net and a pyrethroid-piperonyl butoxide net both when unwashed (77% with PermaNet Dual vs. 23% with PermaNet 2.0 and 56% with PermaNet 3.0,  $p < 0.001$ ) and after 20 standardised washes (75% with PermaNet Dual vs. 14% with PermaNet 2.0 and 30% with PermaNet 3.0,  $p < 0.001$ ). Using a provisional non-inferiority margin defined by the World Health Organisation, PermaNet Dual was also non-inferior to a pyrethroid-chlorfenapyr net that has demonstrated improved public health value (Interceptor G2), for vector mortality (79% vs. 76%, OR = 0.878, 95% CIs 0.719–1.073) but not for blood-feeding protection (35% vs. 26%, OR = 1.424, 95% CIs 1.177–1.723). PermaNet Dual presents an additional option of this highly effective net class for improved control of malaria transmitted by pyrethroid-resistant mosquitoes.

## Abbreviations

PBO	Piperonyl butoxide
ITN	Insecticide treated nets
LLIN	Long-lasting insecticidal nets
WHO	World Health Organization
PQ	Prequalification team
cRCT	Cluster randomised controlled trial
GLP	Good laboratory practice
CREC	Centre de Recherche Entomologique de Cotonou
LSHTM	London School of Hygiene & Tropical Medicine

Insecticide-treated nets (ITNs) are the most effective and widely adopted preventive measure against malaria. They have been consistently shown to reduce malaria morbidity and mortality under trial<sup>1</sup> and programmatic conditions<sup>2</sup>, and have made the largest contribution of any intervention to recent reductions in malaria<sup>1</sup>. Their

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# Global Fund Announces New Mechanism to Increase Access to More Effective Mosquito Nets to Prevent Malaria

22 August 2023

**Geneva** – The Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund) is launching a new Revolving Facility to negotiate improved supply terms for global health products for the countries it supports. This financial mechanism uses advanced market commitments, including volume guarantees, to drive more affordable access to quality-assured health products and accelerate health product introductions and innovations at greater scale.



# Durability

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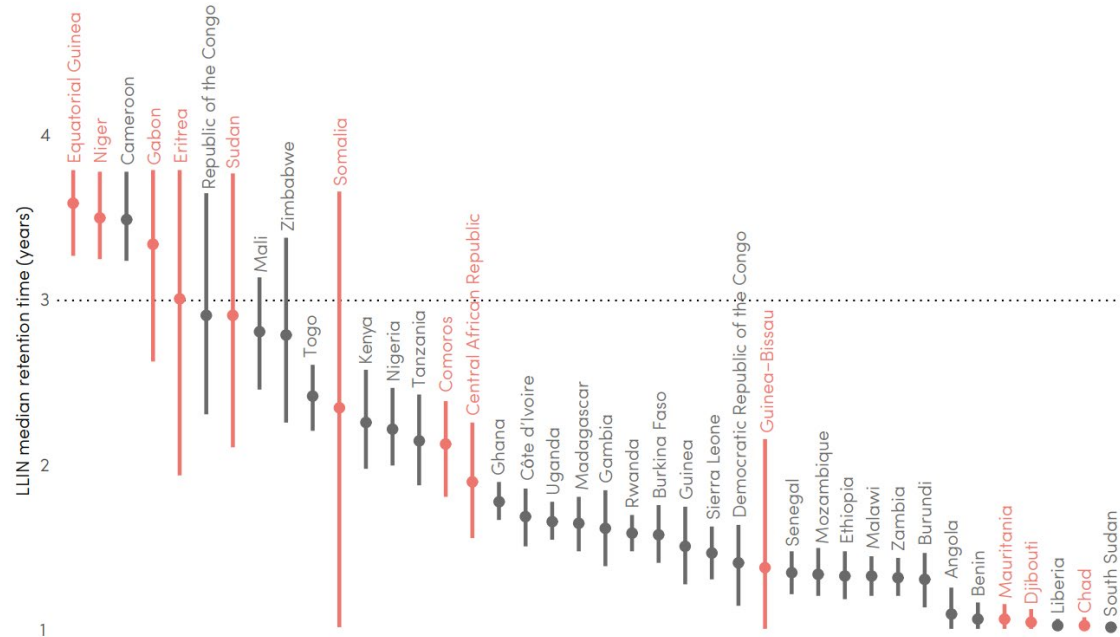


# Durability

World Malaria Report 2022: **Median retention is 1.9 years; nets are discarded sooner than they are replaced mainly owing to the development of holes**

**FIG. 9.7.**

**Median LLIN retention time by country, ordered from highest to lowest** Dots show mean parameter values, and vertical bars indicate 95% CI width. Countries with fewer surveys have less stable model fits; those having fewer than three surveys are indicated in red. Source: Bertozzi-Villa et al. (2021) (69).



CI: confidence interval; LLIN: long-lasting insecticidal net.

## Median survival time of PermaNet 3.0 (years)

Country	Monitoring Month	PermaNet 3.0
Burkina Faso	12 months	2.9 <sup>a&amp;b</sup>
Mozambique		
Nigeria		
Burkina Faso	24 months	2.9 <sup>a</sup>
Burundi		1.7 <sup>a</sup>
Rwanda		3.5 <sup>a</sup>
Sierra Leone		4.8 <sup>a</sup>
Tanzania	36 months	
Burkina Faso		3.2 <sup>a</sup>

### References:

- a. PMI ITN durability monitoring reports (2022-2023): <https://www.pmi.gov/resources/>
- b. PATH New Nets Project Interim report July 2022



## LLIN durability

1. Innovation to improve physical (fabric) durability
2. Metrics – how to measure durability
3. Value of increase durability– ‘*cost per year of functional life*’



PermaNet®



2.0 by VESTERGAARD

PermaNet®



3.0 by VESTERGAARD

PermaNet®



Dual by VESTERGAARD

