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Elimination and reuse of malaria control inputs wastes, case of plastic packaging of long-lasting impregnated mosquito nets distributed during mass distribution campaigns

Yves Eric Denon*[1,2], Mariette Glitho[2], Clement C Gnimadi[4] Filémon Tokponnon[1,3], Hector Fassinou[1], Désiré Missikpode[1], Guy Appolinaire Mensah[5]

[1]*National Malaria Control Program, Ministry of Health, Benin*

[2]*National Public Health Laboratory, Ministry of Health, Benin*

[3]*Centre de Recherche Entomologique du Benin, Benin*

[4]*Centre Béninois de Recherche Scientifique et de l'Innovation, Benin*

[5]*Institut National de Recherche Agricole du Bénin, Benin*

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Abstract

Approximately 4,674,800 insecticide-treated nets were distributed in Benin for universal coverage during July 2011 mass distribution campaigns by the National Malaria Control Program. Then, Benin faces the challenge of disposing millions of LLINs plastic packaging. The study is conducted in 34 health districts. The 2011 campaign permit to distribute 4,674,800 mosquito nets out of the 4,884,713 LLINs i.e. 95.7%. The dissemination of this plastic packaging in nature is sustainable and unattractive because their biodegradability is very difficult, which could have a negative impact on the environment, biodiversity and human beings. Packaging was stored in the health facilities in each department and conducted to the coordination. Then, NMCP organised the collection in order to recycle this waste. LLIN distribution produced a significant amount of plastic waste estimated at 89.15 tonnes. Several brands of LLINs were distributed during 2011 LLIN campaign and the routine distribution in 2012. 67.3 tonnes of plastic waste collected were shredded in machines for processing on a pilot scale at the DECAM BETHESDA destruction site. The remaining 22.2 tonnes (75.19%) were incinerated. This study has shown that there are alternative uses for plastic waste from LLIN distribution campaigns to minimise the risks associated with the spread of plastic waste in nature as well as the adverse effects on the environment.

***Corresponding Author:** Yves Eric Denon ✉ denric2000@gmail.com

Introduction

In Benin, the Ministry of Health is committed to implementing actions aimed at preventing and combating infectious diseases, including malaria and diseases with epidemic potential. It is in this sense that actions to strengthen the fight against infectious diseases are being implemented in the different health zones of Benin, with the support of technical and financial partners. The National Malaria Control Program has opted for integrated vector control in its control strategies. The use of LLINs is one of the effective measures of the Vector Control and prevention component. The use of LLINs generates waste in the form of plastic packaging containing insecticide residues.

In the period from 2007 to 2011, the NMCP organized two campaigns for free mass distribution of LLINs: the first took place in October 2007, when approximately 1,600,000 LLINs were distributed to children under five years of age in Benin, and the second, in July 2011, when 4,674,800 LLINs were distributed to households in Benin for universal access. In addition, routine household distribution of LLINs to pregnant women and children under five years of age was also carried out.

These periodically organised campaigns produce huge quantities of biomedical waste in health facilities and in the communities covered. This waste has a negative impact on the environment and can be dangerous for humans, biodiversity and the environment when not managed properly.

In order to minimise the risks associated with these dangers as well as the harmful effects on the environment, a plan for the management of the waste resulting from these campaigns has been drawn up. To this end, at the level of the various programs, documents are available on the management of waste resulting from the prevention campaigns.

This study presents the orientations for the management of waste from LLIN mass distribution campaigns in the districts of Benin.

Material and method

The campaign waste management process consists of two multi-stage options:

Waste collection at the peripheral level: Health Center

Packaging and packaging materials for the LLINs were collected daily by agents at the distribution sites and stored in bags at a secure location.

Within 48 hours of the end of the distribution period, the stocks of waste collected at the distribution sites were transported from the various health centres located in the districts to the zone offices using the locally available means of transport (tricycle, cart.), in compliance with safety instructions.

Figure 1. Waste collection and storage at LLIN distribution sites and storage in bags.

Removal and transport of plastic waste to destruction sites

The truck of the NMCP and that of CAME passed by the 14 zone offices where collection had not been carried out to collect the empty packaging generated pre-collected and stored. Six labourers were recruited to assist the convoying team for loading. These packages are then conveyed to the destruction site in Pahou where six maneuvers ensured the unloading. At each loading and unloading the PNLP was present to follow the operations.

Figure 2. Unloading of plastic waste at the destruction site.

Recycling and Incineration or final disposal on the DECAM BETHESDA site

Incineration and final disposal

A total of 22.2 tonnes of waste, i.e. approximately 24.80% of the plastic waste stream collected as part of this LLIN distribution operation, was incinerated and permanently disposed of on this site in a suitable incinerator. The flue gases are passed through a water-containing piping system to prevent environmental pollution through the emission of gases such as carbon dioxide.

Figure 3. CISSE LABEL type incinerator in Africa.

Equipment and material

Machines, labelled incinerator, nose mask, Gloves Combinations Boot, Plastic bags Briquette Match, Oil.

Operating mode

- ✓ Preheating of the incinerator
- ✓ Filling of the oven by the bags
- ✓ Firing
- ✓ Closing of the incinerator

Production frequency Regular (daily operation)

Finished products: Complete combustion ash and low toxicity smoke

Figure 4. Non-electric artisanal incinerator.

Recycling or transformation into paving stones

As for the second batch, it was crushed and transformed into domestic paving stones and plastic pipes to prevent their spillage into nature. This involves 67.3 tonnes of plastic waste, i.e. approximately 75.20 tonnes.

This raw plastic waste was initially shredded. The product obtained is as follows:

Figure 5. Products resulting from the shredding of Olyset Net type packaging.

These shreds were used in the production of building materials, particularly domestic paving stones. This process consists of liquefying the sachets with sand in the correct dosage, moulding and cooling them to obtain paving stones.

Description of the method

The method is that of the mixer, which is a mechanical method that allows you to work in complete safety and to have the best paving qualities both in terms of resistance and aesthetics. It allows the ideal dosage to be respected in the manufacture of paving stones.

This method has made it possible to process around 67.3 tonnes of packets while complying with environmental health and safety standards.

How the workshop works

It is a workshop installed since 2014. It is a section for the promotion of valorisation experiences. It deals with the transformation of plastic bags and other plastic waste into paving stones to be used as building materials.

Equipment/machinery

Machines, Mixer Moulds, Moulding, Table electric current, Safety equipment, Nose mask Gloves Combinations Boot, Material, Inputs Sachets Sand Water

Figure 6. Handcrafted mixer used on the site.

Operating mode

Mixing the liquefied bag with sand in the blender. Heating of the mixture until a homogeneous leg is btained. Homogeneous moulding of the leg, Cooling Demoulding, Regular production frequency based on current demand. Production capacity (mixer capacity per reach); 5 to 7 pavers for 120 kg of plastic packaging. A total of 3,500 units of paving stones manufactured and sold. This represents an enormous profit for the company DECAM BETHESDA.

Figure 7. Final product obtained (paving stones).

Result

The fight against malaria produces a lot of waste. Some of the waste generated by malaria control inputs is destroyed in health centres in accordance with the national policy for the management of biomedical waste. These are :

- ✓ rapid diagnostic test cassettes
- ✓ gloves
- ✓ vaccinostyles
- ✓ pipettes or handle or inverted cup
- ✓ bag containing the used TDR cassette
- ✓ plastic packaging of the TDR
- ✓ consumables used

ITN packages and expired drugs are destroyed by other processes with monitoring from the central level. The Beninese Agency for Pharmaceutical Regulation destroys expired drugs by fire, with special procedures to ensure that expired drugs are not used for other purposes.

Data processing

The quantities of LLIN packaging transported to the sites are weighed on arrival at the destruction site. These quantities are recorded by the LDPN in a database. This LLIN distribution produced a significant amount of plastic waste estimated at 89.15 tonnes. Several brands of LLINs were distributed during this 2011 LLIN campaign and the routine distribution in 2012.

Of the 89.5 tonnes of plastic waste collected, 67.3 tonnes were shredded in machines for processing into building materials (paving stones) on a pilot scale at the DECAM BETHESDA destruction site. The remaining 22.2 tonnes were incinerated in suitable incinerators. This represents a recycling rate of 75.19%.

Impacts of poor LLIN waste management on people and the environment

Among the waste produced, the LLIN packaging from the 2011 distribution campaign was not removed for destruction until the last quarter of 2012 and the first half of 2013. This packaging remained in the health centers for at least two dry and two rainy seasons throughout the country. In some health zones, the quantities of waste were so large that there was no room to store them. They were then exposed to the weather. This exposure resulted in pollution of the surrounding waters, proliferation of larval gites and mosquitoes and exposure to the insecticides used to impregnate the nets.

The environmental impact of mismanagement of LLIN packaging is mainly due to the pollution of air, water and soil by the insecticides used for impregnation. Air pollution results in emissions of suspended particles, smoke and odour into the atmosphere. The main source of emissions is mainly due to the uncontrolled incineration of waste containing packaging, which produces complete or incomplete combustion of

carbon compounds with the release of carbon dioxide or carbon monoxide.

Table 1. Mass of LLIN packaging used in the 2011 distribution campaign.

Brands	Dawa plus®.	Olyset®	Permanet®.	Net Protect
Packaging weight (g)	18,4	18,1	17,9	18,6

The average weight is 18.25g.

Table 2. Waste mass of LLIN packaging used in the 2007 and 2011 distribution campaigns.

Source of waste	Campaign 2007	Campaign 2011	Routine distribution 2012
Mass of waste (*in tonnes*)	27,38	89,15	9,22

The gases released have the property of mixing with many other gases in the atmosphere such as oxygen, nitrogen, natural carbon dioxide as well as suspended particles and fly ash. These ashes contain a highdose of toxins, especially heavy metals. Despite their low proportion in the atmosphere, these gas mixtures have quite significant health effects. They cause nuisances such as allergies, pneumonia, bronchitis, cancer, nausea etc. Carbon monoxide (co) is very toxic and impairs the oxygenation of body tissues. Other compounds such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), hydrochloric acid (HCL), ammonia vapours (NH_3) can come from the incineration of chemicals and plastics. These substances are very dangerous for the lungs and heart and can cause irritation to the mucous membranes and eyes. Heavy metals are among the most toxic compounds. The effect of these pollutants is much more noticeable in harmattan times when the atmosphere is overloaded with dust. Water pollution is mainly due to run-off, leaching, and the activities of animals and other living organisms.

Rainwater, through the phenomenon of runoff, infiltration and lateral circulation, favours the migration and dispersion of chemical and organic substances and foreign bodies such as pathogenic bacteria and viruses that participate in the contamination of the water table. The phenomenon is much more pronounced in sandy soil characterised by high soil permeability. Compounds such as sulphate ions (S_04), ammonium (NH_4) nitrites (N_03) as well as heavy metals and pathogenic germs can be found in the water and cause serious health problems for humans, especially when in sensitive doses.

Water and soil pollution are directly linked. The soil is subject to aesthetic pollution resulting from the discharge of waste. Plastics prevent the circulation of water towards the depths of the soil, making it difficult for plants to absorb water. In addition, the burning of chemical products such as chlorine and its assimilates and the plastics contained in this waste can be the basis of acid rain. Acid rain carries substances that pollute soil and water. These toxic products can also kill the pedofauna and microfauna that fertilize the soil by decomposing the litter, thus disrupting plant life.

Difficulties

However, significant dysfunctions remain at all stages of the waste management procedure, leading to the burning of waste in the open air on certain distribution sites, and the accumulation of waste on the premises of certain CSPSs due, among other things, to the lack of functional incinerators.

Figure 8. Incineration hole at CS Ayi Guénou in Grand Popo.

Conclusion

Plastic material, present today in various fields and in all conceivable forms, poses real environmental and health problems all over the world. Thus, to try to remedy these problems that its massive use generates, a system of recycling, use or even accumulation of

plastic material has been set up. This made it possible to recycle an average of 67.3 tonnes of plastic bags. However, these solutions found do not completely solve these problems. Recycling remains too neglected by consumers or too expensive. Thus, research and subsequently the establishment of other methods are necessary. We could therefore, for the future, put in place other more profitable methods.

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