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## CRITICAL ANALYSIS OF MOSQUITO REPELLENTS FORMULATION IN THE BRAZILIAN MARKET

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### ABSTRACT

Mosquitoes are responsible of a wide variety of infectious agents to humans. Malaria, dengue, yellow fever and other diseases transmitted by mosquito bites affect millions of people worldwide causing thousands of deaths each year, causing a major impact on the health services. National programmes to fight vector-borne diseases are based on controlling the mosquito population with the use of insecticides in an attempt to interrupt the cycle of these diseases. Unfortunately, insecticide-resistant mosquitoes have already existed in many areas of the world. In Brazil, due to the difficulties in controlling mosquitoes, potential opportunities for intervention arise through innovations that can contribute to minimizing the current problem. We can highlight the use of mosquito repellents as an opportunity. The main aim of this work was to analyze and compare commonly commercialized repellent products in Brazil, designed to repel mosquitos, describing their composition according to ideal parameters for these products reported in scientific literature and also Brazilian legislation. It was a bibliographical review which was carried out using Scielo, Google Scholar and PubMed platforms to look for studies in national and international scientific literature. In addition, Brazilian legislation on the subject was used. The following keywords were used: mosquito, repellents, raw materials, and cosmetics. These keywords were searched for in Portuguese, Spanish and English. Despite the importance of repellents for public health, there is little variety of actives ingredients and formulations. The most important actives ingredients to repel mosquitos are DEET, Icaridina and IR3535. And the formulations in Brazilian market are lotion, liquid and gel. Even though only a small fraction of the Brazilian population buys repellent products, commercial brands should invest in this sector with effective, safe, not harm the environment and have a good residual products.

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## INTRODUCTION

According to the World Health Organization (WHO), vector-borne diseases are responsible for 17% of all infectious diseases causing more than 700,000 deaths annually. It is estimated that around 3.9 billion people are in the risk of contracting dengue and it is estimated 96 million cases per year. Globally, malaria causes more than 400,000 deaths per year and the most of them among children under 5 years old (WHO, 2019). Most of the pathogens that cause infectious diseases in humans are in the nature in cycles that involve a vector and a wild animal. However, with the changes in the environment caused mainly by economic activities, a lot of mosquitoes have taken this place, favoring the transmission of these pathogens to humans, which facilitates the development of epidemics (LIMA-CAMARA, 2016; NORRIS, 2004). Mosquitoes are responsible of a wide variety of infectious agents to humans.

Malaria, dengue, yellow fever and other diseases transmitted by mosquito bites affect millions of people worldwide causing thousands of deaths each year, causing a major impact on the health services (GABRIELI, 2014). National programmes to fight vector-borne diseases are based on controlling the mosquito population with the use of insecticides in an attempt to interrupt the cycle of these diseases. Unfortunately, insecticide-resistant mosquitoes have already existed in many areas of the world (HEMINGWAY, 2000; TAYLOR, 1975; RUSSEL, 2011; SOUGOUFARA, 2014). The fact that human populations for reasons of work, study or leisure are increasingly entering, in the area of these vectors, increases the risk of contagion through contact of contaminated mosquitos with the human host. Therefore, vector control is one of the most important components in the control program for these diseases, and its main objective is to reduce the morbidity and mortality caused by these diseases, reducing the transmission. In Brazil, due to the difficulties in controlling mosquitoes, potential opportunities for intervention arise through

innovations that can contribute to minimizing the current problem. We can highlight the use of mosquito repellents as an opportunity. The main aim of this work was to analyze and compare commonly commercialized repellent products in Brazil, designed to repel mosquitos, describing their composition according to ideal parameters for these products reported in scientific literature and also Brazilian legislation.

## MATERIALS AND METHODS

This work is a bibliographical review which was carried out using Scielo, Google Scholar and PubMed platforms to look for studies in national and international scientific literature. In addition, Brazilian legislation on the subject was used. The following keywords were used: mosquito, repellents, raw materials, and cosmetics. These keywords were searched for in Portuguese, Spanish and English. Discussion and results were based on the products from four brands which commercialize products designed to work as skin insect repellent. Analysis consists of comparison among products, assessing their characteristics, formulation composition and current legislation. For such, key ingredients were assessed: active ingredient, reapplication period and use in children.

## RESULTS AND DISCUSSION

According to the hypothesis proposed by McMahon et al. (2003), repellents are compounds that act in the vapor phase (volatiles) inhibiting the response of arthropods to attractants, while deterrents are compounds that act by contact inhibiting the response to an arresting stimulus. In accordance with Pickett et al. (2008), repellency can be described as a behavior caused by the stimulation of peripheral

sensory neurons, causing a non-feeding stimulus in the arthropod and moving away from the treated host. Substances with an unpleasant odor such as tar and animal urine have been used for millennia to ward off parasitic arthropods. The ideal repellent should have the following characteristics: have long-term effectiveness against a wide variety of arthropods; not irritate the skin immediately after its application on it or on clothing; not affect clothing by staining, bleaching or weakening the fabric, remaining on clothing after repeated washing; be inert to everyday plastics; resist water and sweat and leave no oily residue on the skin; not be toxic; have a long-lasting effect; have a viable cost that allows its frequent use; and not being aggressive to the environment (FRADIN, 2007; GILBERT, 1966; GOODYER, BEHENS, 1994; GUPTA, 1994; KATZ, 2008; SHERMAN, 1966). In Brazil, all repellents sold need to be approved by the National Health Surveillance Agency (ANVISA) and there are currently two legislations required to register a repellent product, RDC 19 of April 10, 2013 and TECHNICAL NOTE No. 01/2018 - GHCOS/DIARE/ANVISA and these products must present, at the time of application for registration, studies about effectiveness of the product proving that they actually repel insects. There is a great range of repellents brands spread worldwide. Among these few are S.C. Jonhsons, Reckitt Benckiser and Johnson&Johnson. Thus, four products designed from different Brazilian market brands were chosen and analyzed, as shown in Table 1. Description of appeal and of functions of key-ingredients and critical analysis of each product are shown in Table 2. Product 1 contains fewer ingredients and the application period is 6 hours. It can also be used on children. Product 2 is a liquid product with natural compounds. The product appeal as a repellent is due to the presence of organic citronella essential oil. The application period is shorter than product 1, only 3 hours. And it can not be used on children. Product 3, on the other hand, has the tradicional active ingredient (DEET). His appeal is the natural hydration with Aloe Vera. The application period is the shortest of all products discussed in this article, only 2 hours.

Table 1. Products for insect repellent

Product	Brand	Net content / Net weigh	Cosmetic form	Active Ingredien
1	Exposis Bebê - Repelente	117g	gel	ICARIDINA 10%
2	Citrojelly Loção Repelente Corporal	120mL	liquid	IR3535 10% + <i>Cymbopogon nardus</i> Oil 2%
3	Off! Family Loção Repelente	200mL	lotion	DEET 7,79%
4	Johnson's Baby Loção Antimosquitos	200mL	lotion	IR3535 12,5%

Table 2. Key ingredients, functions and appeal of the assessed products

PRODUCT 1 – Exposis Bebê Repelente			
Marketing claims	Reapplication Period	Key-ingredients and functions	For use in Children
<ul style="list-style-type: none"> <li>Highly effective repellent;</li> <li>It is an insect repellent whose icaridin-based formula can be used on babies from 3 months;</li> <li>Protects against the bites of <i>Aedes aegypti</i> (Dengue, Chikungunya and Zika);</li> <li>The repellent recommended by doctors.</li> </ul>	6 hours	<ul style="list-style-type: none"> <li>Icaridina (Hydroxyethyl Isobutyl Piperidine Carboxylate): active ingredient</li> <li>Alcohol: solvent</li> <li>Glycerin: skin moisturizing agent</li> <li>Polyacrilic Acid: preservative</li> </ul>	Allowed
PRODUCT 2 – Citrojelly Loção Repelente Corporal			
<ul style="list-style-type: none"> <li>Natural and vegan repellent, with organic citronella essential oil.</li> </ul>	3 hours	<ul style="list-style-type: none"> <li>Ethyl Butylacetylaminopropionate (IR3535): active ingredient</li> <li><i>Cymbopogon nardus</i> Oil: active ingredient/fragrance</li> <li>PEG-40 Hydrogenated Castor Oil: emulsifier</li> <li>Ethylhexylglycerin: preservative</li> </ul>	Not Allowed
PRODUCT 3 – Off! Family Loção Repelente			
<ul style="list-style-type: none"> <li>Protection and natural hydration with Aloe Vera.</li> </ul>	2 hours	<ul style="list-style-type: none"> <li>Diethyl Toluamide (DEET): active ingredient</li> <li>Petrolatum: moisturizing agent</li> <li>Sodium Chloride: soothing properties in the skin</li> <li><i>Aloe barbadensis</i>: soothing properties in the skin</li> <li>Cetyl Alcohol: emollient</li> <li>Propil Paraben: preservative</li> </ul>	Not Allowed
PRODUCT 4 – Johnson's Baby Loção Antimosquitos			
<ul style="list-style-type: none"> <li>Safe and smooth;</li> <li>Protects against insects;</li> <li>Hypoallergenic / Alcohol Free.</li> </ul>	4 hours	<ul style="list-style-type: none"> <li>Ethyl Butylacetylaminopropionate (IR3535): active ingredient</li> <li>Butylene Glycol: solvent</li> <li>Citric Acid: pH adjustment</li> <li>Disodium EDTA: chelating agent.</li> </ul>	Allowed

And it can not be used on children. Product 4 is a lotion with the IR3535 active ingredient, the same of the product 2. Its appeal is the safety, smoothness and hypoallergenicity. The application period is 4 hours. And it can be used on children as product 1. In the Brazilian Market, the repellent products have the following cosmetic forms registered in the National Health Surveillance Agency (ANVISA): liquid lotion, gel, emulsified lotion, aerosol, cream, aqueous lotion, oil and hydroalcoholic lotion. The differentiation of these cosmetic forms is the structure of the formulation (OETTERER, 2016). Emulsions, creams and lotions are basically heterogeneous systems consisting of immiscible phases with the surfactant presence with emulsifying action. The difference of these cosmetic forms are the viscosity degree. The creams are higher viscosity degree than in emulsions and lotions because they have hydrophilic and/or lipophilic characteristics. Lotions have lower viscosity and lower grease load, therefore they are sensorially lighter and more volatile products (OETTERER, 2016). Gels are hydrocolloidal solutions formed by a semi-solid which, when in contact with a liquid, has a thickening action, increasing the formulation viscosity because they have good spreadability and low oily load. This cosmetic form is widely used for skin grease and for cosmetics that give feeling of freshness. Aerosols are suspensions or emulsion of liquids in the presence of gas that result in the dispersion of this product under pressure. It is a highly volatile cosmetic form (OETTERER, 2016).

## CONCLUSION

Insect repellents serve a valuable purpose by discouraging biting insects, which can cause itching, pain, parasites and disease. Despite the importance of repellents for public health, there is little variety of active ingredients and formulations. The most important active ingredients to repel mosquitoes are DEET, Icaridina and IR3535. And the formulations in Brazilian market are lotion, liquid and gel. A very important factor for the good performance of a repellent is the period that the product is acting in the skin. The fewer reapplications, the better, because in everyday life people forget to apply the repellent. Even though only a small fraction of the Brazilian population buys repellent products, commercial brands should invest in this sector with effective, safe, not harm the environment and have a good residual products.

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