

nanoXIM•CarePaste: The Enamel Repair Ingredient

Effectiveness of nanoXIM•CarePaste on dentin tubule occlusion and enamel remineralization

About dental hypersensitivity

Dental hypersensitivity is a major, common dental condition that **occurs in approximately 57% of adults**. Among individuals with periodontal disease, the prevalence can reach as much as 98% [1]. The condition usually arises as a result of continuous teeth erosion brought about by the action of foods, drinks and hot and cold temperatures that expose the dentin and underlying nerves, as shown in Figure 1 and 2A. As a result, external stimuli are transmitted to the nerves, causing brief but intense pain.

Dental hypersensitivity is usually treated by applying desensitizing toothpastes mainly composed by strontium chloride or potassium nitrate. However, these products do not simulate the natural composition and structure of dentin and enamel [2].

The **mineralized tissues found in the human body are mostly composed of hydroxyapatite (HAp)**, a natural calcium phosphate ceramic that is abundant in dentin (70%), enamel (97%) and bone (60%). **Tooth enamel is the hardest tissue in the human body and is made up of building blocks of HAp nanocrystals**, 40nm in size. The tissue is acellular and unlike bone, **cannot be naturally repaired** [2]. Regenerating the surface of tooth enamel therefore poses a significant challenge.

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The **nanoXIM•CarePaste** is a nanocrystalline HAp paste produced and marketed by FLUIDINOVA. This **synthetic nano-HAp** aqueous paste has been specifically made for oral care applications, such as mouthwashes, toothpastes and chewing gums. Nano-HAp is one such material that is being utilized in medicine and dentistry, owing to its **excellent bioactivity** and **biocompatibility** as well as its similarity to the mineral component of teeth and bone. This calcium phosphate is already being used in oral care formulations and offers a number of benefits, such as effective **reduction of teeth sensitivity** [3, 4], **fast enamel remineralization** [5-7], **improved smoothness** of tooth surface and **whitening** [8, 9].

nanoXIM•CarePaste contains high purity nanoparticles under 50 nm in size and with a high specific surface area. This product is naturally preserved and complies with dentifrices and food-grade standards.

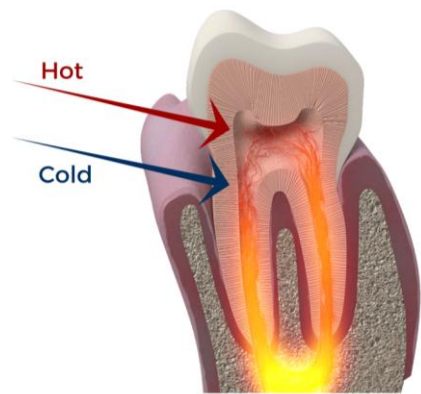


Figure 1: Dental hypersensitivity as a result of exposed dentin tubules in response to hot and cold stimuli.

Unlike micro-sized HAp, the tiny nano-HAp is easily integrated into the dentin tubules, enhancing their occlusion (Figure 2B). This **seals the tubules** and prevents exposure of the nerves to external stimuli, thereby reducing dental hypersensitivity. Moreover, nano-HAp has a higher surface area, biological activity and chemical reactivity, which facilitate its binding to the dentin apatite and tooth enamel. This creates a new apatite layer that remineralizes the enamel and protects the surface of the tooth. This layer protects the tooth from the damage caused by acids in food and drinks (Figure 2C) as well as whitens the tooth and makes it smoother, as shown in Figure 2D [2].

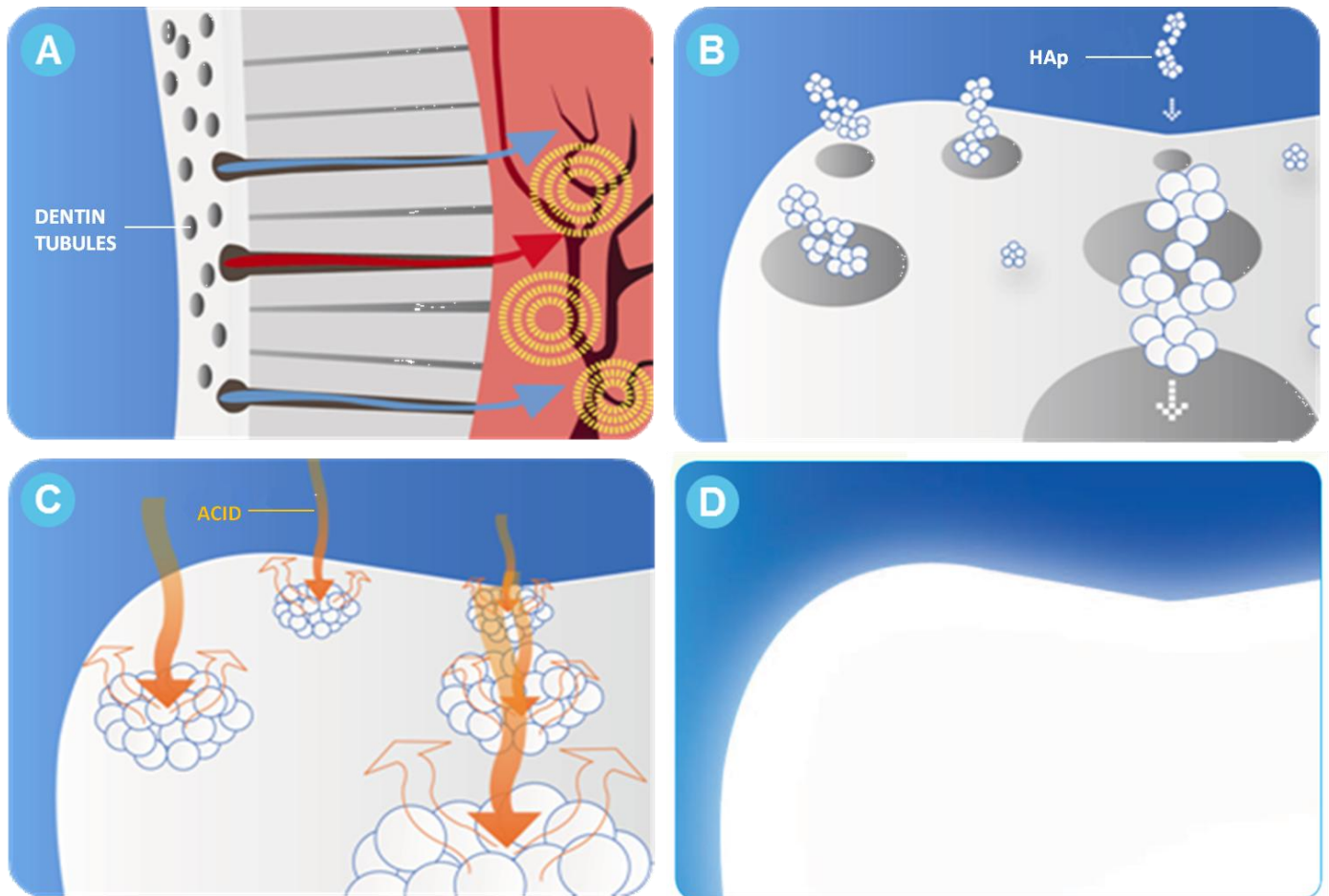


Figure 2: (A) Exposure of dentin tubules to hot and cold temperatures stimulates nerves and causes pain; (B) nano-HAp fills dentin tubules binding chemically to dental structure reducing hypersensitivity; (C) nano-HAp remineralizes the tooth enamel protecting it against acid attacks from food and beverages; (D) improved smoothness and whitening due to enamel repair by nano-HAp.

A number of studies have been conducted to demonstrate the effectiveness of nanoXIM•CarePaste at reducing dental hypersensitivity and promoting enamel remineralization.

Effect of nanoXIM•CarePaste on Dental Hypersensitivity

To demonstrate the efficacy of nanoXIM•CarePaste in dentin tubule occlusion, an *in vitro* study was carried out using artificial saliva and human teeth. In this study, a toothpaste containing 15 % of nanoXIM•CarePaste was compared with a regular toothpaste [10]. The results showed that the toothpaste containing **nanoXIM•CarePaste occluded more dental tubules than the regular toothpaste did**. In fact, after seven applications, the toothpaste containing nanoXIM•CarePaste occluded **up to 75%** of the dentin tubules (Figure 3).

Another study demonstrated the effectiveness of nanoXIM•CarePaste in occluding dentin tubules as well as showing that the product is sustained even after washing [11].

Dentifrices that contain nanoXIM•CarePaste are therefore excellent at promoting dentin tubule blockage and reducing dental hypersensitivity.

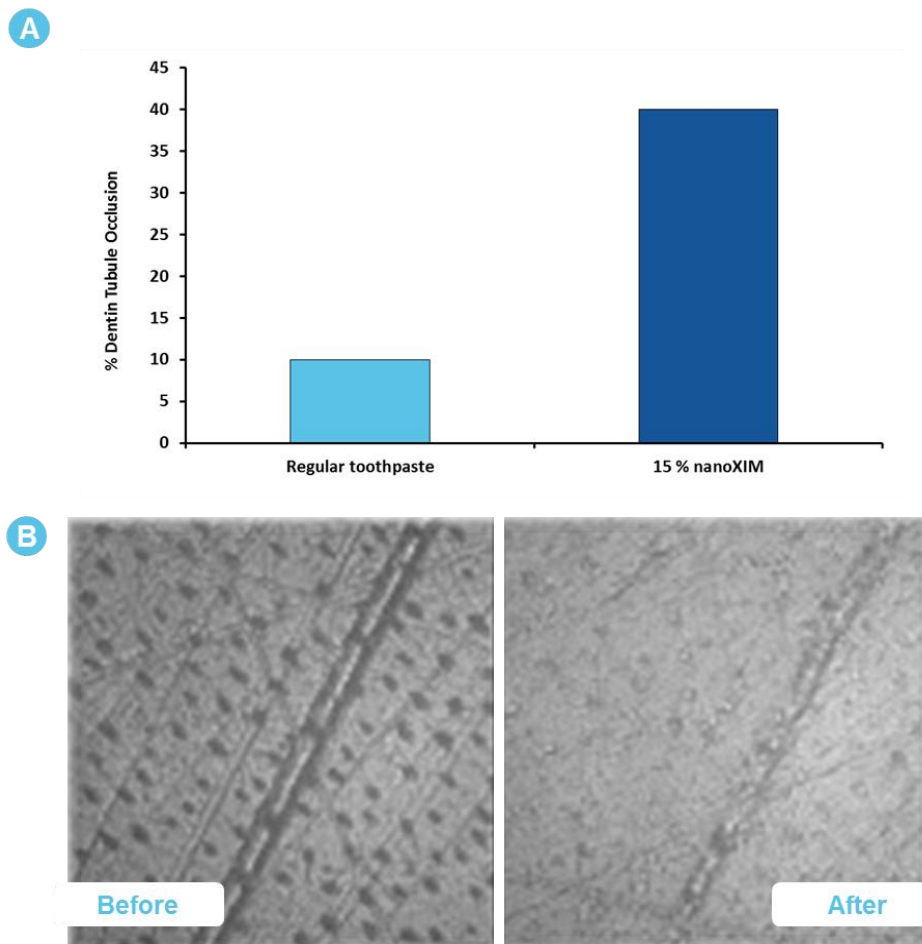


Figure3: (A) Comparison of dentin tubule occlusion with regular and nanoXIM toothpaste. (B) Light microscope images illustrating the dentin tubules before and after the treatment with a nanoXIM•CarePaste dentifrice.

To test the rates of dentin tubule occlusion, another *in vitro* study compared a dentifrice containing nanoXIM•CarePaste with Colgate Pro-Relief™ Pro-Argin™ technology.

nanoXIM•CarePaste-based toothpaste from Aclaim, Group Pharmaceuticals led to a **high degree of tubule occlusion after just two minutes** (Figure 4), which was **five times faster** than the occlusion rate seen with Colgate Pro-Relief™ [12].

This further demonstrates that nanoXIM•CarePaste is an excellent product for blocking dentin tubules and reducing hypersensitivity.

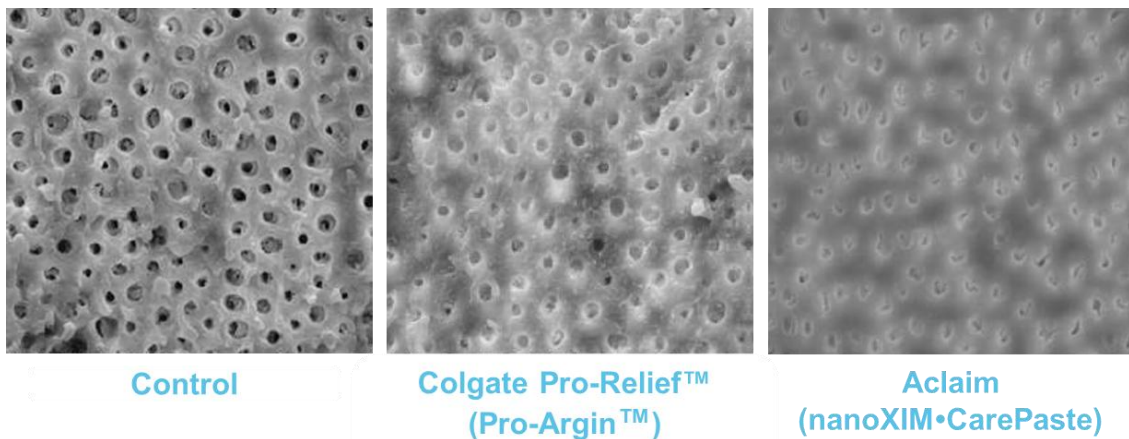


Figure 4: Effect of Colgate Pro-Relief™ and nanoXIM•CarePaste-based toothpaste on dentin tubule occlusion after two minutes of treatment. A sample without treatment (control) was also analyzed. Data gently provided by Group Pharmaceuticals Ltd., India.

Clinical Study

An *in vivo* clinical study of 45 patients was performed to test the efficacy of nanoXIM•CarePaste (Aclaim), potassium nitrate (Sensodent-K) and propolis dentifrices in controlling dental hypersensitivity [13]. Propolis is a natural, non-toxic resin that can occlude dentin tubules and reduce their permeability, whilst potassium nitrate is known for reducing dentinal sensory activity. The Visual Analog Scale for Pain was used to test the patients' dentin hypersensitivity before and after using the different dentifrices. Figure 5 shows the results after one and four weeks of treatment using the three different dentifrice varieties.

A greater pain reduction was observed among the patients treated with the nanoXIM•CarePaste dentifrice than with the other two varieties, suggesting that a formulation containing nanoXIM•CarePaste is the most likely to reduce dental hypersensitivity.

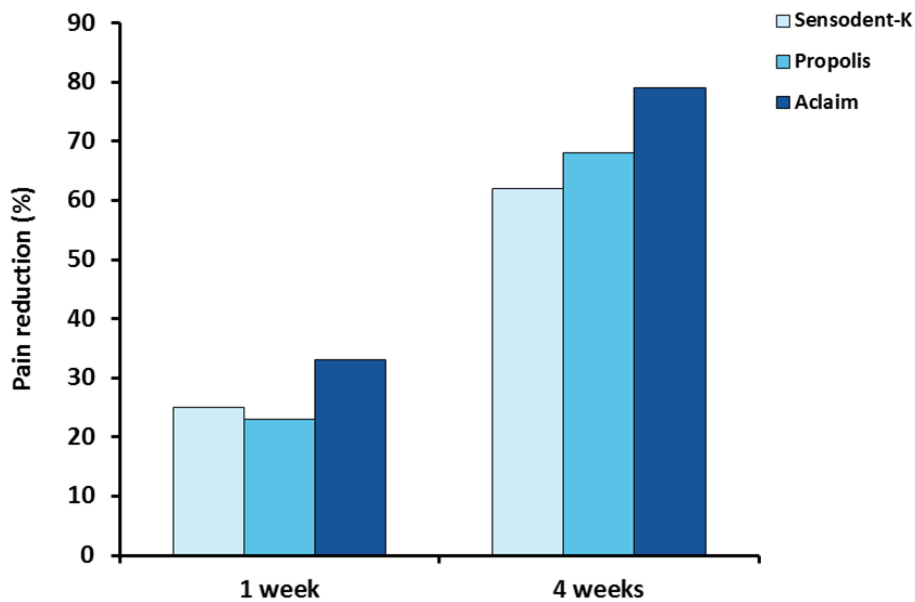


Figure 5: Reduction of dental hypersensitivity after treatment with potassium nitrate (Sensodent-K), Propolis and nanoXIM•CarePaste (Aclaim) during one and four weeks.

Effect of nanoXIM•CarePaste on Enamel Remineralization

An *in-vitro* study was performed to test the remineralization potential of a nanoXIM•CarePaste-based toothpaste compared with a Casein PhosphoPeptide-Amorphous Calcium Phosphate (CPP-ACP) dentifrice [14].

For the study, carious lesions were created in teeth by exposing them to demineralizing solution for 96 hours. The teeth were then treated using the two different dentifrices. The carious lesions were assessed using a diode laser fluorescence device called the DIAGNOdent Pen. The lower the value displayed by the DIAGNOdent pen, the greater the remineralization of the carious lesion. Figure 6 shows that nanoXIM•CarePaste was more effective at remineralizing the lesion than the CPP-ACP dentifrice.

nanoXIM•CarePaste promotes crystal growth and its integrity helping to create a new crystalline, remineralized surface.

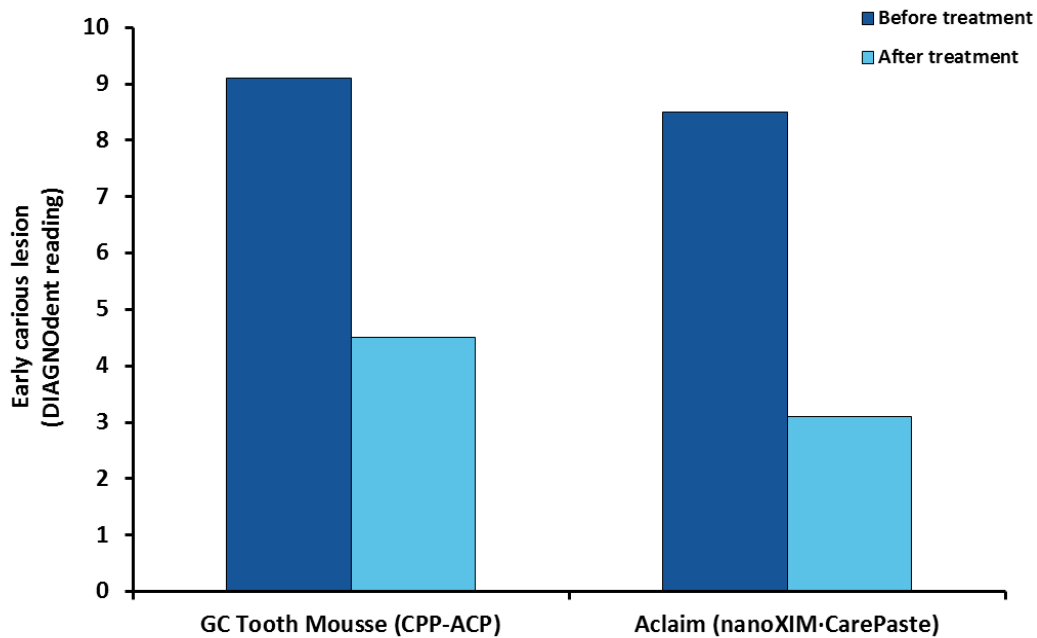


Figure 6: nanoXIM-CarePaste has greater effect than CPP-ACP dentifrice in remineralizing the early carious lesion. Data gently provided by Group Pharmaceuticals Ltd., India.

Conclusions

nanoXIM-CarePaste is an excellent product to include in oral care formulations, effective at occluding dentin tubules and reducing dental hypersensitivity. The product achieves a higher rate of dental tubule occlusion than other commercial brands and remains on the teeth even after washing. Moreover, nanoXIM-CarePaste can repair damaged enamel and promote remineralization and the new biomimetic apatite layer formed by nano-HAp helps to create a whiter and smoother tooth surface.

References

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