ECOLOGICALLY FRIENDLY CONSTITUENTS IN MATERIALS USED IN MINIMALLY INVASIVE DENTISTRY

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Introduction and Objectives

Minimally invasive dentistry (MID) is defined as the greatest preservation as possible of healthy dental tissues. All procedures for managing caries, including risk assessment, caries diagnosis, and prevention, and minimally invasive treatments including fluoride therapies and atraumatic restorative treatment, can be incorporated into MID.[1]

The damage caused by human beings to the earth and the resulting climate change is a vital issue that needs to be emphasized in the field of dentistry.[2] The scantiness of research on the ecologically friendly constituents of materials used in MID necessitated this research.

The objective of this study was to investigate the level of incorporation of ecologically friendly constituents in materials used MID and to increase the awareness of both manufacturers and dentists as consumers.

MATERIALS	CATEGORY	ECO-FRIENDLY BRANDS	CONVENTIONAL MATERIALS INGREDIENTS	ECOLOGICAL MATERIALS INGREDIENTS
Toothbrush	Instruments	Humble/Brush with Bamboo/Alterra/T-brush/Preserve/The Environmental Toothbrush/Etee/Radius/ScentCerae/Denttabs/Burshd/Bambino/O'Nano/WooBamboo/Boca Pura/Bogobrush/OraMD	Plastic: polypropylene/polyethylene (handle/bristles) Nylon-4/nylon-6 (bristles)	Humble Brush: 100% biodegradable, sustainably-grown bamboo (a handle) Nylon-6: 40% ricin oil (bristles) Natural wax (vegan)
Tooth Paste	Chemical	Urtekram/Eyüp Sabri Tuncer/T-brush/The lifeco/One Drop Only/Etee/Butter Me Up Organics'/Georganics/Radius/ScentCerae/Denttabs/Pärla	Sensodyne Toothpaste (With Titanium Dioxide): Glycerin % 0 - 61.5 Sodium Bicarbonate % 0 - 25 Colloidal Anhydrous Silica % 0 - 24 Silica, Amorphous Hydrated % 0 - 24 Silicon Dioxide % 0 - 24 Polyethylene Glycol % 0 - 20 Calcium Carbonate % 0 - 10 Zeodent 113 % 3 - < 5 Potassium Pyrophosphate, Anhydrous % 0 - 5.1 Novamin 4516 % 0 - 5 Potassium Nitrate % 0 - 5 Sodium Tripolyphosphate % 0 - 5 Cocoamidopropyl Betaine % 0 - 4 Potassium Chloride % 0 - 3.8 Polyethylene Glycol Stearate % 0 - 3 Dodecyl Sodium Sulfate % 0 - 2	Urtekram – Toothpaste Mint: Calcium Carbonate Aqua Xylitol Glycerin Aloe Barbadensis Leaf Extract Hydrated Silica Commiphora Myrrha Gum Oil Mentha Arvensis Oil Mentha Piperita Oil Mentha Viridis Leaf Oil Menthol Magnolia Officinalis Bark Extract Sodium Fluoride Xanthan Gum Aroma Limonene
Dental Floss	Instruments	Humble/Etee/Dental Lace/Georganic	Oral-B Super Floss: 2-Propenoic acid, 2-hydroxyethyl ester, polymer with 1,1'-methylenebis[4-isocyanatocyclohexane] and 2-oxepanone >50% Benzophenone 1-3%	Humble Dental floss - Lemon: Nylon Candelilla Wax (Euphorbia Cerifera) Xylitol Citral (Natural aroma)
Interdental Brush	Instruments	Humble/Hydrophil/Piksters	Plastic: polypropylene/polyethylene (handle/bristles) Nylon-4/nylon-6 (bristles)	Humble Interdentsal Brush: Bamboo (a handle) Nylon-6: 40% ricin oil/ BPA free (bristles) Natural wax (vegan)
Tongue Scraper	Instruments	The LifeCo/PAAVANI Ayurveda/ Brush with Bamboo	Plastic	100% Stainless Steel/Copper

Table 1. Table of dental materials used in MID identified as eco-friendly brands and compositions.

Materials and Methods

- PubMed/Medline Databases: from 1950 until 2021
- MSDS: from 2018 until 2022
- Distinct global dental manufacturers: N=17
- Reviewed articles: N=54
- Composition of materials and instruments: N=34
- Products that have to be listed only as hazardous substances: N=3
- Products that do not have eco-friendly alternatives: N=5

Data Collection Process

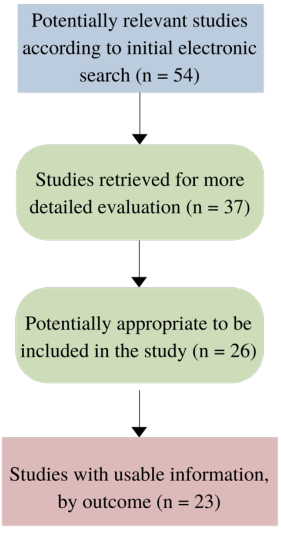

Fig. 1. Flowchart for the studies included in the review.

Results

A total of 8 articles on the overview of materials used in MID and 46 articles on the subject of sustainability were evaluated. Out of 17 dental manufacturers, 8 lacked an ecological policy while 13 of them included ecological products or programs in their product assortment. Only 9 of them integrated entirely ecological products or programs.

As shown in the Tables 1-2, there are differences between conventional and ecological ingredients in their materials.

The outcome of the reviewed articles on the subject of sustainability indicated that there is a lack of sustainability policy in dentistry. Thus, development of research and education, and the necessary steps have been taken late compared to other sectors.

MATERIALS	CATEGORY	ECO-FRIENDLY BRANDS	CONVENTIONAL MATERIALS INGREDIENTS	ECOLOGICAL MATERIALS INGREDIENTS
Mouthwash	Chemical	Urtekram/Alterra/Deenthal Pro/Humble	Ivoclar Cervitec Liquid: Aqua Glycerin Xylitol Panthenol Chlorhexidine Digluconate Laureth-23 Aroma Sucralose	Urtekram BIO9® Strong Mint Sensitive Mouthwash: Aqua Glycerin Aloe Barbadensis Leaf Extract Xylitol Commiphora Myrrha Gum Oil Glycyrrhiza Glabra Root Extract Mentha Piperita Leaf Extract Salix Purpurea Bark Extract Zinc Citrate Lactic Acid Sodium Hydroxide Menthol Levulinic Acid P-Anisic Acid
Toothpick	Instruments	Preserve	Talcum Power/Plastic/Wooden	Sustainably harvested birch wood All-natural oils
Chewing Gum	Chemical	Humble	Orbit Spearmint Gum: Sorbitol Gum Base Glycerol Hydrogenated Starch Hydrolysate Aspartame Mannitol Acesulfame K Soy Lecithin Xylitol BHT	Humble Natural Chewing Gum-Fresh Mint: Xylitol 73,5% Natural gum base Natural flavours Glycerol Magnesium stearate Arabic gum Carnauba wax
Mirror, Periodontal Probe, Explorer, Excavator, Scaler, Curets	Instruments	PDT/Hu-Friedy/American Eagle Instruments	Steel (Fe, C, Si, Mn, P, S, Cr, Mo, Ni, Al, Cu, Nb, B, Ti)	Satin Steel
Pit and Fissure Sealants	Chemical	Pulpdent Corp/Septodont	Ivoclar Helioseal F Plus: UDMA HEMA phosphate Aromatic aliphatic UDMA Al fluorosilicate glass Silicon dioxide Polyacrylate	**Pulpdent Corporation - Embrace Wetbond Pit And Fissure Sealants: Uncured acrylate ester monomers % 55 - 60 Silica, amorphous % 5 Sodium fluoride % <2
Fluoride Gel	Chemical	Pure Life Dental/Medicom	Topex 60 Second Fluoride Gel Mint: Magnesium Aluminum Silicate Saccharin Sodium Titanium Dioxide % 0.1-1 FD&C Yellow No.5 Spearmint Xanthan Gum Purified Water Hydrofluoric Acid FD&C Blue No.1 Phosphoric Acid % <2 Sodium Benzoate Xylitol Polysorbate 20 Anhydrous Citric Acid Sodium Fluoride % 2.7	Medicom Fluoride, 1.23% Gel: Sodium Fluoride % 1-3 Phosphoric acid % 1-3
Fluoride Varnish	Chemical	Pulpdent Corp	**GC MI Varnish: Ethyl alcohol 25-<50% Sodium fluoride 5-<10%	**Pulpdent Corporation - Embrace Varnish: Hydrogenated Rosin <35% Ethanol, 190 Proof <20% Sodium Fluoride 5% Amorphous Fumed Silica <3%
Polishing Paste	Chemical	Pure Life Dental	3M Clinpro Prophy Paste: 3,6,9,12,15,18,21-Heptaoxatricosane-1,23-diol 35-45% Perlite 35-45% Ethoxylated Castor Oil 1-5% Palmityl Alcoho 1-5% Sodium Fluoride 1-5% Titanium Oxide 1-5% Sodium Saccharin <5% Flavor <5%	Pure Life Prophy Paste: Glycerol ≥25 - <50% Sodium Silicate ≥3 - <5% Sodium Fluoride ≥1 - <3%

**: Only the hazardous ingredients of the products were listed on the SDS

Table 2. Dental materials used in MID are categorizeda as eco-friendly brands and their chemical compositions.

Conclusions

- Raising awareness among patients, physicians, dental teams and consumers from travel to material selection and encouraging them to make more ecological choices in MID is needed.
- Manufacturers should be promoted to pursue a more ecological policy. This policy demands material constituents be re-examined and replaced with more environmentally friendly alternatives.
- It is predicted that increasing demand and variety with awareness and incentives will reduce costs and pricing thereby increase the consumption of eco-friendly products. There is a need for detailed economic research in the field of dental materials.

References:
1- Gao SS, Du M, Maharani DA. Editorial: Minimally Invasive Dentistry for Caries Management. Front Oral Health. 2022;3:940177.
2- Duane B, Stancliffe R, Miller FA, Sherman J, Pasdeki-Clewer E. Sustainability in Dentistry: A Multifaceted Approach Needed. J Dent Res. 2020;99:998-1003.