



Gum4Gum: The First Chewing Gum To Prevent Cavities

Jihyun Hwang, Tony Jung, Noelle Nicol, Juliet Okorie
 Chemical and Biomolecular Engineering Product Design Team N
 Johns Hopkins University



Competitive Landscape of the Hygiene Industry

\$49.5 Billion Oral Hygiene Market by 2028
 Market needs a product to balance cleanliness and ease of access

	Traditional Oral Care	On-the-go Oral Care	Bite Tablets	Chewing Gum	Gum4Gum
Cost	★ ★	★	★	★ ★ ★	★ ★
Acessible	★	★	★	★ ★ ★	★ ★ ★ ★
Cleaning	★ ★ ★	★ ★ ★	★ ★	★	★ ★ ★ ★
Travel	★	★ ★	★ ★	★ ★ ★	★ ★ ★ ★
Low-Waste	★	★	★ ★ ★	★ ★	★ ★ ★ ★

Motivation Behind Gum4Gum

Tooth decay is breakdown of the enamel on the tooth primarily caused by bacteria. Bacteria utilizes sugar and carbohydrates in foods to produce acids that attack the teeth's surface. The aggregation of bacteria with these components are called plaque and will eventually lead to the formation of cavities when left untreated.

Ingredient	Xylitol	Fluoride	Chlorhexidine acetate	Gum Base	Glycerin	Flavor
Purpose	Kill bacteria by taking away energy source. Sweetener	Strengthen teeth enamel by adding mineral	Antibacterial properties	Filler, softener, adhesive	Softener that increases flexibility of gum	Adds flavoring to increase salivary flow rate
Weight %	66.95	0.0173	0.33	25	6.50	1.20
Weight (g)	1.0	0.0003	0.005	0.3	0.1	0.02
Price per g (\$/g)	0.004	0.7	0.005	0.06	0.0007	0.01
Price (\$)	0.004	0.0002	0.00003	0.002	0.00007	0.0002

Table 1: Gum4Gum ingredient compositions and technical/financial specifications. A piece of gum weighs 1.5 g and costs \$0.007.

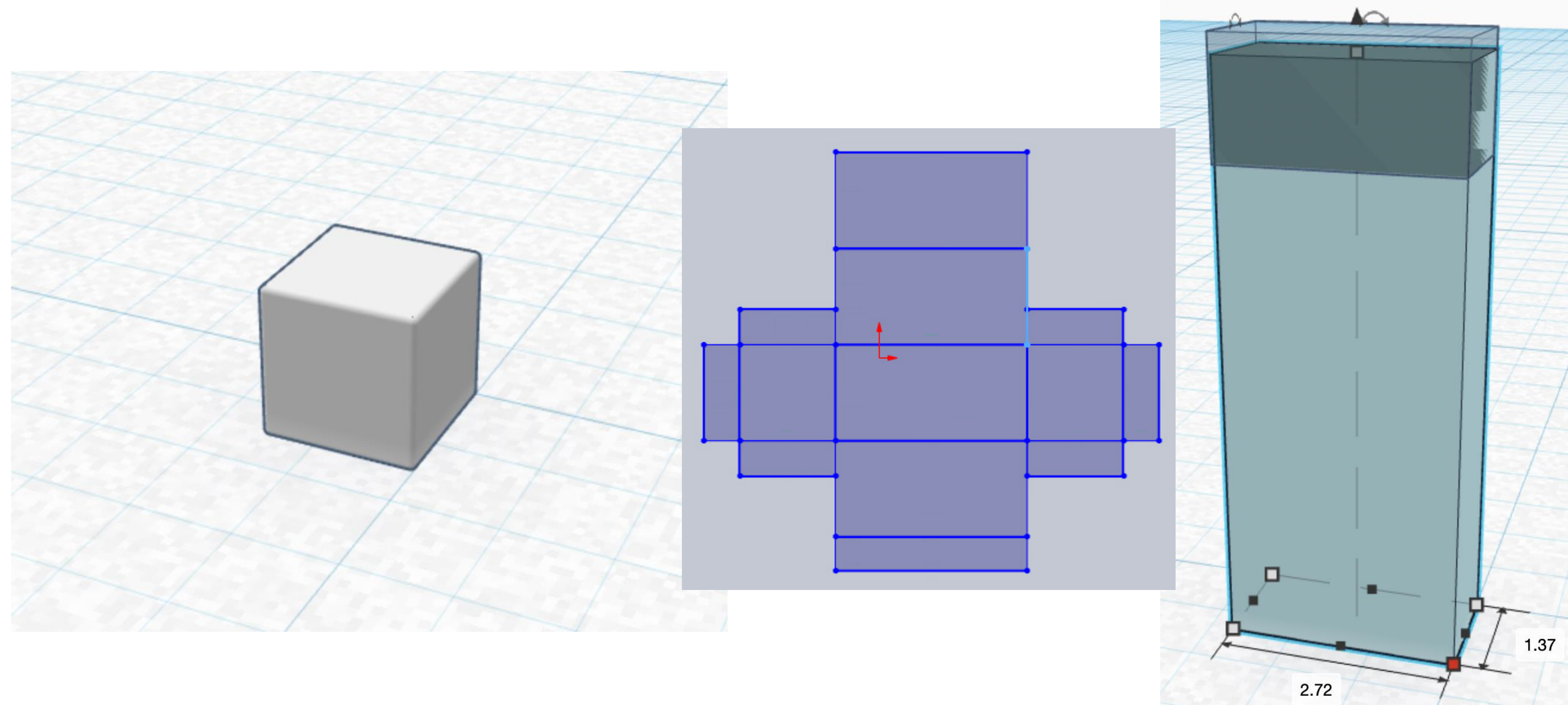


Figure 1: Schematics of Gum4Gum pieces and packaging created in TinkerCAD and Solidworks. The pieces are cubes with 1.35 cm³ sides and are packaged in a 2.72 cm x 1.37 cm x 6.77 cm aluminum and reinforced paper box.

Manufacturing Gum4Gum: The Direct Fusion Method

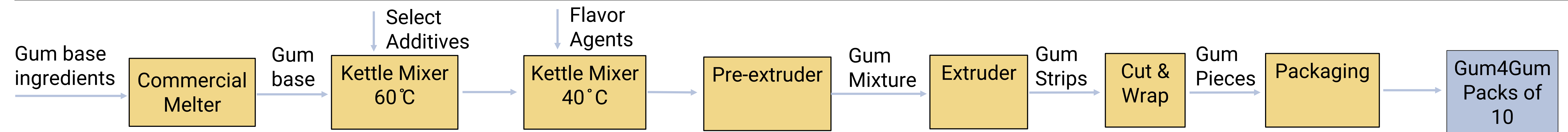


Figure 2: The Process Flow diagram of the Direct Fusion Method for gum manufacturing is presented above. Gum Base ingredients start in the melting tank at 60 degrees C where they homogenize. The kettle mixer is where additives, texturizers, and flavorings are introduced. The temperature of the kettle mixer is reduced to 40 degrees C before the flavoring agent is added. The gum mixture enters the pre-extruder for flattening into uniform sheets. After cooling in the chamber (3-7 degrees C), the gum is cut and wrapped.

Kinetic Profiles of Gum4Gum Activity

The kinetic models were generated in MATLAB using a three-compartment pharmacokinetic model with researched fluoride parameters. The fluoride acts in the mouth by binding to calcium ions in teeth to reverse the decalcification caused by tooth decay.

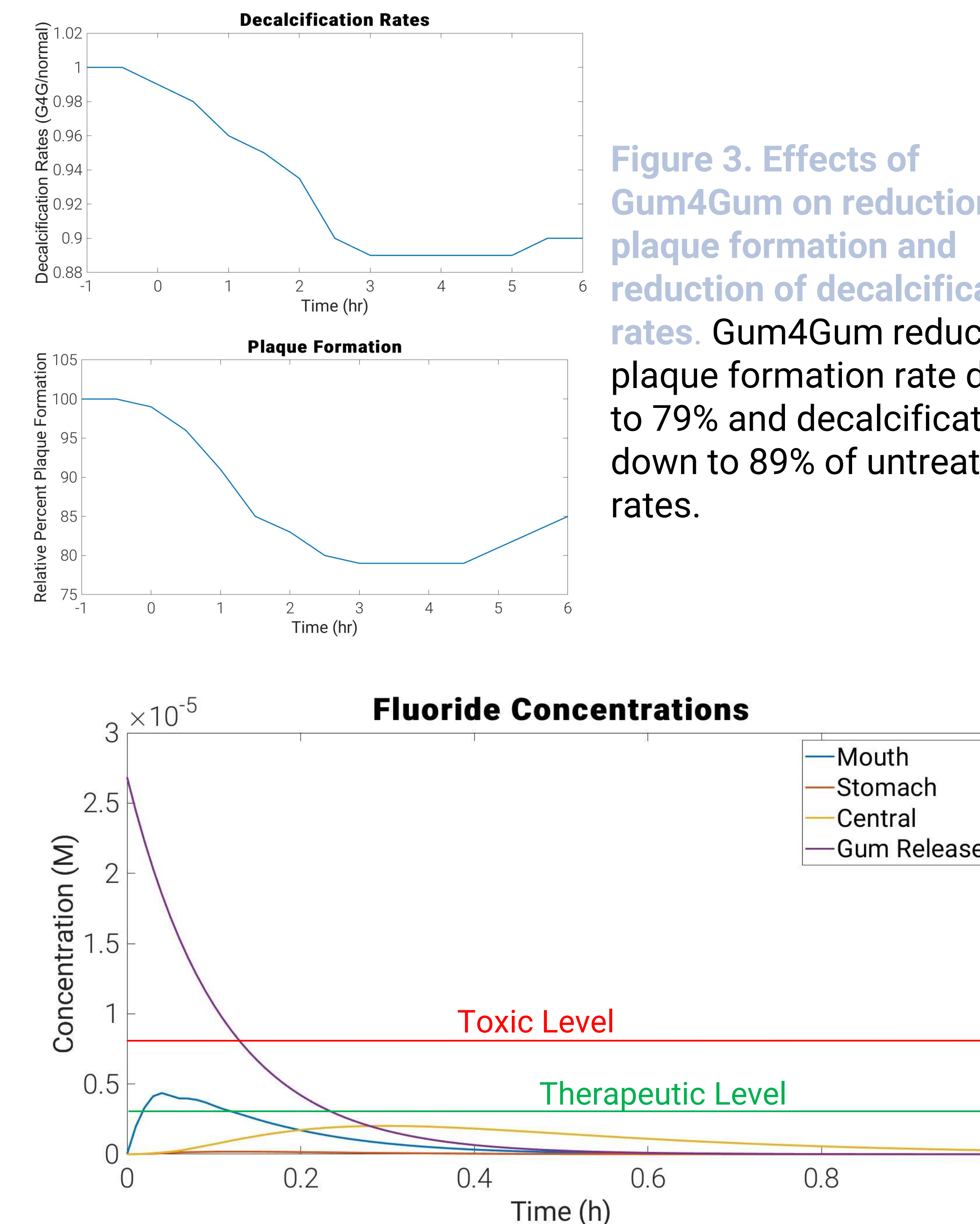


Figure 3. Effects of Gum4Gum on reduction of plaque formation and reduction of decalcification rates. Gum4Gum reduces plaque formation rate down to 79% and decalcification down to 89% of untreated rates.

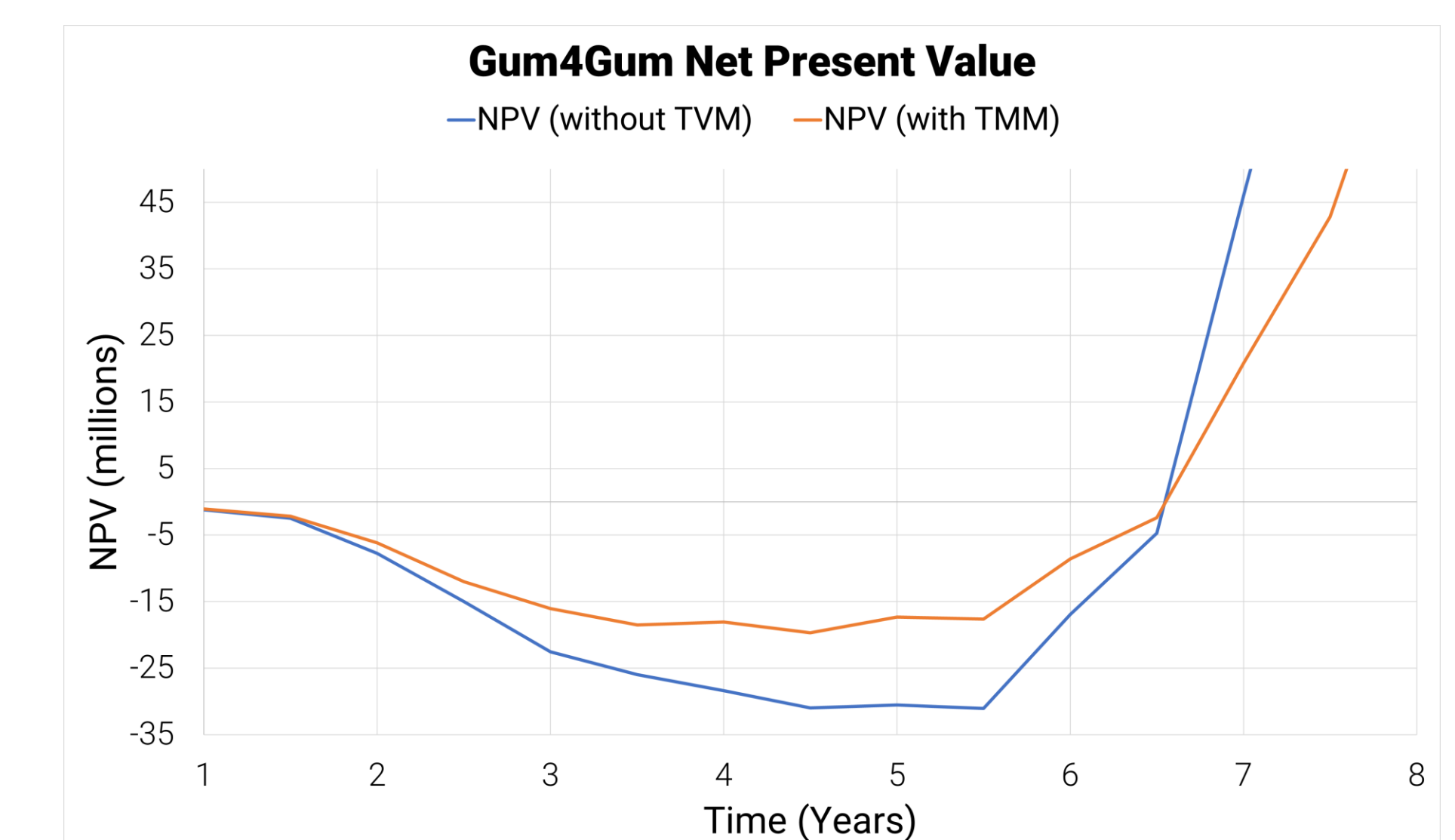
Figure 4. Ideal fluoride weight percent

Fluoride release from each Gum4Gum serving to theoretical 3-compartment system modeling the human body. Model consists of mouth, central, stomach. From continuous chewing, the concentration of fluoride in mouth peaks beyond therapeutic level at 0.05-hour mark and steadily decreases.

Projected Value of the Company

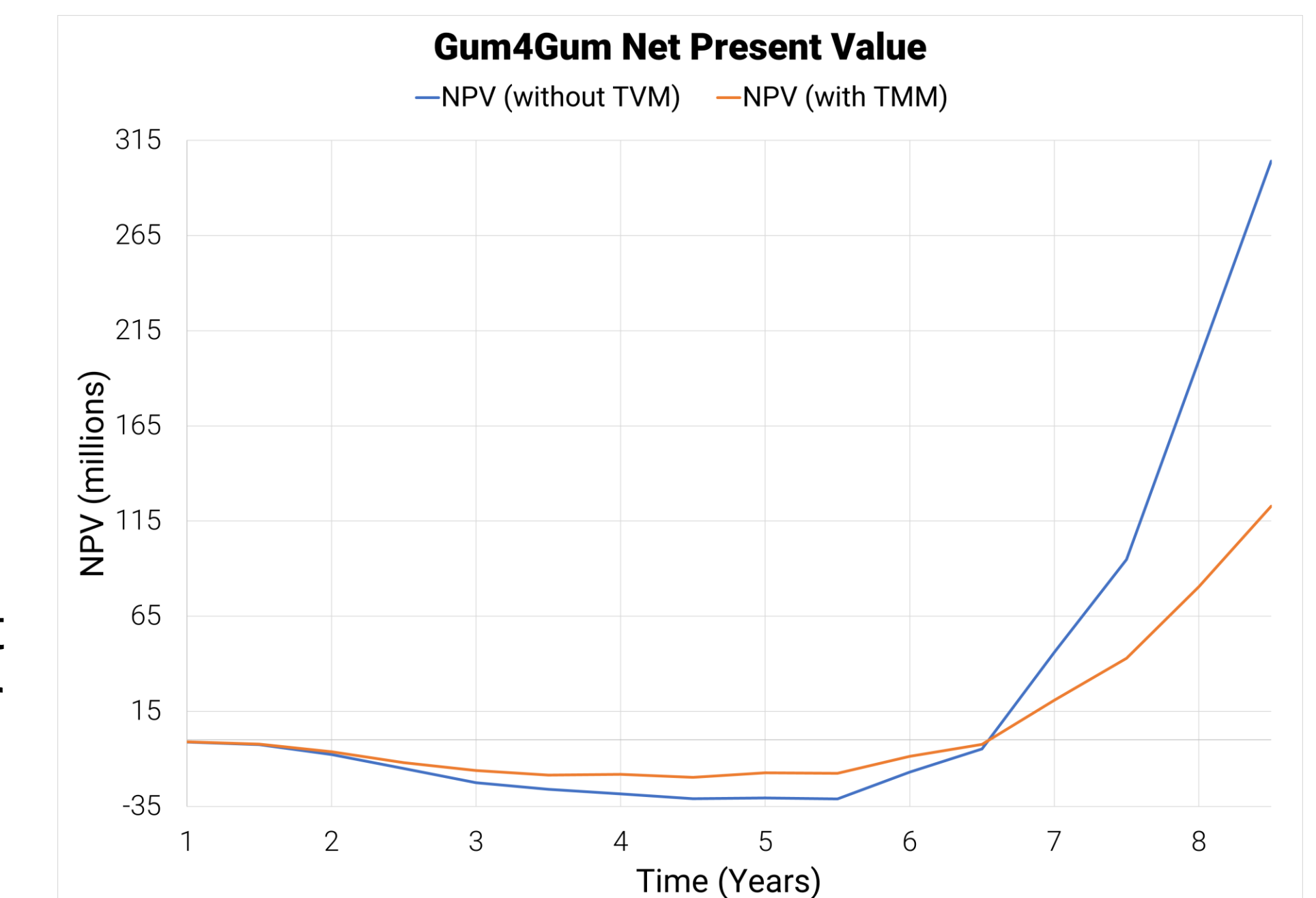
Our costs include:

- R&D
- Clinical Trials
- Process Units
- Manufacturing Costs
- Personnel



Figures 5 and 6: Financial Analysis of Gum4Gum.

Figure 5 depicts a more focused version of figure 6. There is a maximum dip in NPV of -\$32 million USD in the second half of year 5. However, that money is quickly made and Gum4Gum reaches a profit of \$388 million USD in year 9.



Conclusions

Gum4Gum optimizes cleaning efficiency, portability, and ease-of-access unlike any traditional oral care products on the market. By employing active ingredients fluoride, xylitol, and chlorhexidine acetate in the mouth at non-toxic, therapeutic levels, Gum4Gum targets cavity causing bacteria and reduces acidity, thereby thoroughly cleaning the user's teeth while they simply chew.

References & Acknowledgements

Manufacturing Process: Direct Fusion Method

- NCBI: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4468459/>
- Discovery UK: <https://www.youtube.com/watch?v=2kttVyakHN4>
- Drug Bank: <https://go.drugbank.com/drugs/DB09325>