


# A Comparative Evaluation of Xylitol Chewing Gum and a Combination of IgY + Xylitol Chewable Tablet on Salivary *Streptococcus mutans* Count in Children: A Double-blind Randomized Controlled Trial

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## ABSTRACT

**Aim:** The study was designed for evaluation and comparison of the efficacy of Xylitol chewing gum and a combination of IgY + Xylitol chewable tablet (Nodecay™) against the “salivary *Streptococcus mutans*” count in children.

**Materials and methods:** About 120 children belonging to 6–12 years age-group were enrolled into this “double-blind randomized control clinical trial” according to the selection criteria. They were randomly assigned to three groups of 40 each: Group I–Xylitol chewing gum, Group II–IgY + Xylitol Chewable tablet (Nodecay™), and Group III–Control. Children in all the groups had to chew the gum/tablet twice daily for 5 minutes during the 15-day period. The salivary samples at baseline, 15 days, 1, 2, and 3 months were inoculated on mitis salivarius bacitracin agar with potassium tellurite medium and the number of colony-forming units (CFUs) of *Streptococcus mutans* were determined. The data obtained was subjected to statistical analysis.

**Result:** There was a “significant” difference in the number of “*S. mutans* CFUs” amongst the three groups at 15 days, 1st month, 2nd month, 3rd month with highest levels of *S. mutans* CFUs in Group III–Control and least in Group II–IgY + Xylitol (Nodecay™).

**Conclusion:** The combination of IgY + Xylitol (Nodecay™) when administered for 15 days had significant efficacy against “*S. mutans*” when compared to Xylitol and control group.

**Clinical significance:** Passive immunization with immunoglobulin Y is known not only to decrease the *S. mutans* count but also confers extended immunity by preventing recolonization of the tooth surface by persistence of the antibodies in saliva.

**Keywords:** Dental caries, Double-blind, IgY, Immunoglobulin Y, Randomized clinical trial, *Streptococcus mutans*, Xylitol.

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## INTRODUCTION

In today's era, dental caries is a common disease amongst children and adolescents caused by the interplay of three major factors- the host, fermentable carbohydrates, and the acid-producing bacteria.<sup>1</sup> It involves decalcification of the inorganic minerals in the teeth followed by gradual dissolution of the organic matrix leading to cavitation.

*Streptococcus mutans* (*S. mutans*) is one of the most important bacterial species contributing to acid production and demineralization culminating to dental caries.<sup>2,3</sup> Studies in literature have proven the lethal relationship between elevated proportions of *S. mutans* and increased incidence of dental caries.<sup>4</sup> Thus, the strategy to combat dental caries would be to either eliminate this bacterium or suppress its virulence. The potential adverse effects associated with fluorides for prevention of dental caries has promoted the use of alternate treatment strategies like Xylitol chewing gums and oral passive immunotherapy using Immunoglobulin Y (IgY).

Xylitol, a sugar substitute with five carbon atoms, has been shown to drastically reduce tooth decay by decreasing the levels of *S. mutans* in plaque and saliva. Xylitol being nonfermentable by *S. mutans* is widely employed ingredient in chewing gums, tooth pastes, and oral rinses. Chewing gums containing Xylitol in addition to the above antibacterial effects also promote mechanical cleansing and salivary stimulation.<sup>5</sup>

The limitations associated with parenteral caries vaccines have focused attention toward passive immunization. IgY

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exists in the serum of the chickens and their eggs is known as immunoglobulin egg, named for the sedimentation coefficient constant.<sup>6</sup> It has similar physicochemical properties as IgY in mammals, and can help protect the immune system from infection after the immunoglobulin is introduced into the body.<sup>7</sup> Water insoluble glucan is the significant constituent of the dental plaque which facilitates accumulation and aggregation of cariogenic bacteria mediated by glucan-binding proteins. The enzyme “cell

associated glucosyltransferase (CA-GTF) of *S. mutans* plays a key role in synthesizing water insoluble glucan from fermentable carbohydrates present in the oral environment. IgY generated against CA-GTF causes significant reduction in recolonization of dental plaque.<sup>8</sup> IgY not only inhibits the adhesion of microbes but also promotes agglutination and immobilization of the bacteria, enzyme inactivation and neutralization of bacterial toxins.<sup>9</sup>

Since both Xylitol and IgY are capable of decreasing the levels of *S. mutans* individually their combination would produce a synergistic effect against the cariogenic bacterium. Moreover, the combined efficacy Xylitol and IgY against *S. mutans* levels has not been tested much with clinical trials.<sup>10,11</sup> Therefore the present study was designed to evaluate and compare the efficacy of Xylitol chewing gum "(Happydent White Xylitol Chewing Gum™, Perfetti Van Melle Pvt Ltd, India)" and a combination of IgY + Xylitol chewable tablet (Nodecay™, Inzpera Healthsciences Ltd, India) in reduction of salivary *S. mutans* count in children aged 6–12 years by a double-blind, parallel group randomized controlled trial.

## MATERIALS AND METHODS

### Study Design

The present study was a "double-blind, parallel group, randomized controlled trial."

### Ethical Considerations

Before initiation of the study, the corresponding institutional ethical committee reviewed and approved the protocol of the trial. A written consent stating the procedure, its possible discomfort and benefits including the presence of egg derivative in one of the study product was obtained from the parents of the children involved in the study.

### Sample Size Determination

Sample size was determined using the formula,

$$n = 2 (Z_{\alpha} + Z_{\beta})^2 [s]^2 / d^2$$

where  $Z_{\alpha}$  is the z variate of alpha error that is, a constant with value 1.96,  $Z_{\beta}$  is the z variate of beta error that is, a constant with value 0.84."

### Approximate Estimates

- 80% power
- Type I error to be 5%
- Type II error to be 20%
- True difference of at least 23,000 units between the groups
- Pooled standard deviation of 42,000"

Substituting the values gave 31 samples per group; in order to compensate for any drop-outs from the study a sample size of 40 per group was decided.

### Study Subjects

Nearly 150 children were screened at the outpatient department of Pediatric and Preventive Dentistry. From this preliminary examination 120 children aged 6–12 years were enrolled into the study based on the following criteria:

#### Inclusion Criteria

- Children aged between 6 and 12 years of either sex.
- Children with "salivary *S. mutans*" level equal to or more than  $10^5$  "colony-forming units (CFUs)."

- "Decayed-missing-filled-teeth (DMFT)" score equal to or more than 1.

#### Exclusion Criteria

- Children undergoing orthodontic treatment.
- Children with any congenital anomalies or intraoral prosthesis.
- Those with any systemic diseases or temporomandibular joint disorders.
- History of consuming xylitol-containing chewing gums, fluoride therapy or antimicrobial mouth rinses over the past month.
- Children who strictly avoid consumption of egg containing products.
- Children allergic to any material used in the study.

### Randomization

The sequencing was generated using computerized random number table. An independent observer carried out allocation concealment by sequentially numbering the opaque containers of the study formulation according to the randomization. A second investigator allotted the study formulation to the children and gave appropriate instructions. Thus, three groups of 40 children each constituted the sample size as follows:

- Group I: Xylitol chewing gum "(Happydent White Xylitol Chewing Gum™, Perfetti Van Melle Pvt Ltd, India)."
- Group II: IgY + Xylitol Chewable tablets (Nodecay™, Inzpera Healthsciences Ltd, India).
- Group III: Control Group with no intervention.

### Blinding

The participants of the study were blinded to the formulation they received as the outer packaging was removed and repacked in similar looking opaque containers. In addition the primary investigator was blinded to randomization and the procedure of allotting the study formulation to the children. The primary investigator was only involved in baseline and follow-up saliva sample collection and estimation of "salivary *S. mutans* CFUs."

### Steps of Study

Details regarding the child's sociodemographic status, diet, and oral hygiene practices was procured from the accompanying parent/guardian through a self-administered questionnaire.

All children in Group I (Xylitol chewing gum) were asked to chew two pellets of the gum two times a day for 5 minutes after breakfast and dinner for a period of 15 days. Children in Group II (IgY + Xylitol chewable tablet) were instructed to consume one orange chewable tablet from silver foil containing 20 mg IgY after breakfast in the morning and one white chewable tablet from blue foil with 40 mg IgY before bed at night for 15 days. They also had to avoid eating/ drinking up to 1 hour after taking the tablet. Children in all the groups were instructed to brush twice daily, restrict their sugar exposures.

### Saliva Sample Collection

The collection of saliva samples for determination of *S. mutans* levels was done as follows:

- At baseline prior to consuming the tablets,
- 15 days post-completion of Xylitol and IgY + Xylitol use and
- At the end of 1st, 2nd, and 3rd month from baseline.

The children were requested not to consume any food items or drinks an hour prior to saliva sample collection.

For collection of sample, a wax block was used to stimulate salivation and about 2 mL of expectorate was collected in a sterilized container. The samples were stored in ice and transported within 30 minutes for microbial analysis.

### Microbial Analysis

One loop (1/1000th mL of salivary sample) was inoculated on the "Mitis Salivarius Bacitracin Agar with Potassium Tellurite medium (Himedia M259, India)." The plates were incubated in 5 to 10% CO<sub>2</sub> jar at 37 °C for 48 hours. The same investigator processed and evaluated all the culture plates in order to avoid any potential bias. *S. mutans* appeared in pin point sized colonies as round or spherical, dark blue, and convex with rough surface. The colonies were further confirmed using various biochemical test like Gram's staining, catalase test, mannitol and sucrose fermentation test, Arginine test, and Vogues Proskauer test. The colony count of each plate was multiplied with its dilution factor to determine the mean colony-forming units (CFUs/mL).

### Statistical Procedures

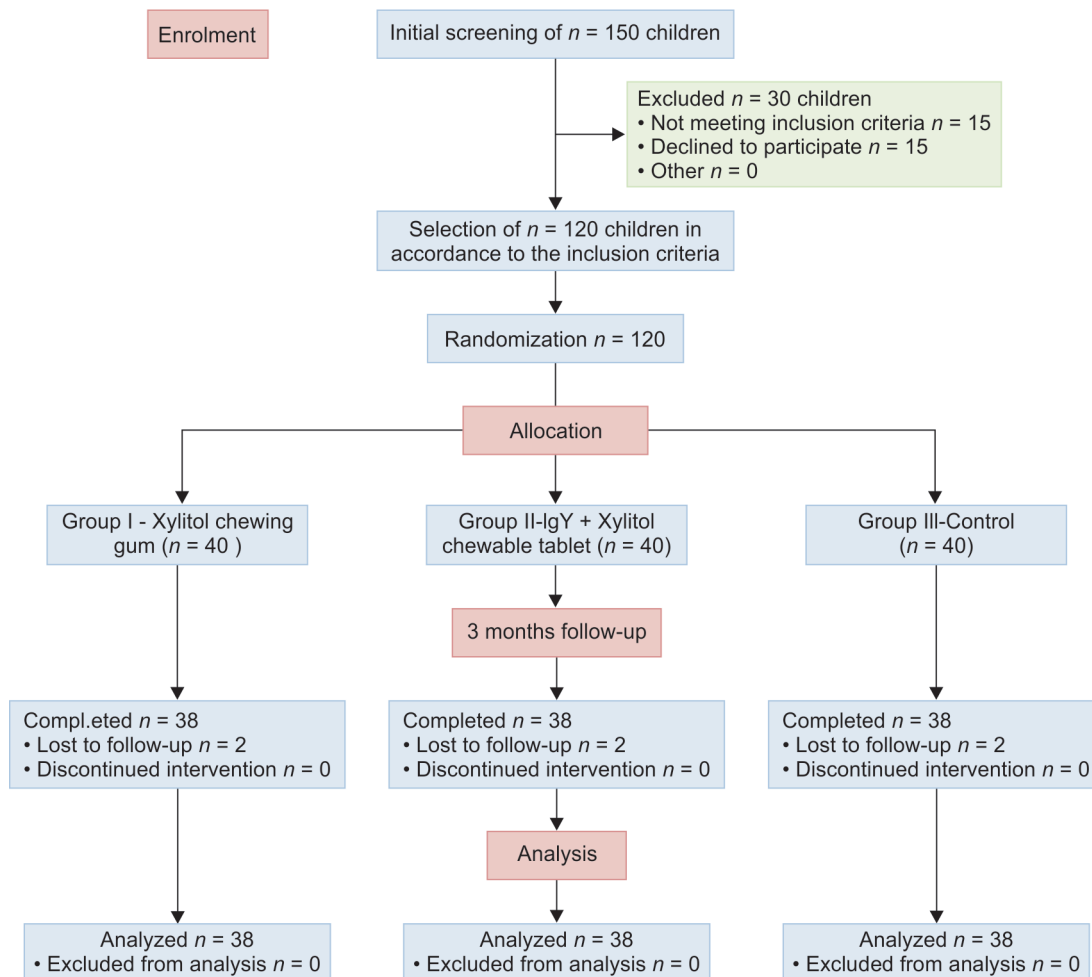
Data obtained was compiled and subjected to statistical analysis using Statistical package for social sciences (SPSS v 21.0, IBM). Non-parametric test were used as the data for CFUs did not follow a normal curve as checked by Shapiro-Wilk test. Inter group comparison (>2 groups) was done using Kruskal Wallis ANOVA

and pair-wise comparison using Mann Whitney U test. Intragroup comparison was done using Friedman's (for >2 observations) and pair-wise comparison using Wilcoxon Signed rank test. Chi-square test was used to compare the frequencies of categories of variables with groups. For all the statistical tests, " $p < 0.05$  was considered to be statistically significant, keeping  $\alpha$  error at 5% and  $\beta$  error at 20%, thus giving a power to the study as 80%."

### RESULTS

Flowchart 1 shows the stream of the participants through the study. The distribution of study population in terms of baseline characteristics as mean age and sex are mentioned in Table 1. There were no statistically significant differences on comparison of three study groups with respect to DMFT, diet, and oral hygiene practices. The *S. mutans* colony count on the mitits salivarius bacitracin agar plates of Group I–Xylitol (Fig. 1), Group II–IgY + Xylitol (Fig. 2), and Group III–Control (Fig. 3) at baseline, 1st month, 2nd month, and 3rd month were determined. The intergroup comparison of *S. mutans* CFUs/mL using Kruskal–Wallis ANOVA (Table 2) showed "no significant difference ( $p > 0.05$ )" in the *S. mutans* CFUs/mL between Xylitol, IgY + Xylitol, and control groups at baseline. However a "highly significant ( $p < 0.01$ )" reduction in the number of *S. mutans* CFUs/mL was seen in Xylitol, IgY + Xylitol, and control groups gradually over 3 months. The maximum reduction in

Flowchart 1: CONSORT flow diagram presenting the stream of patients through the study

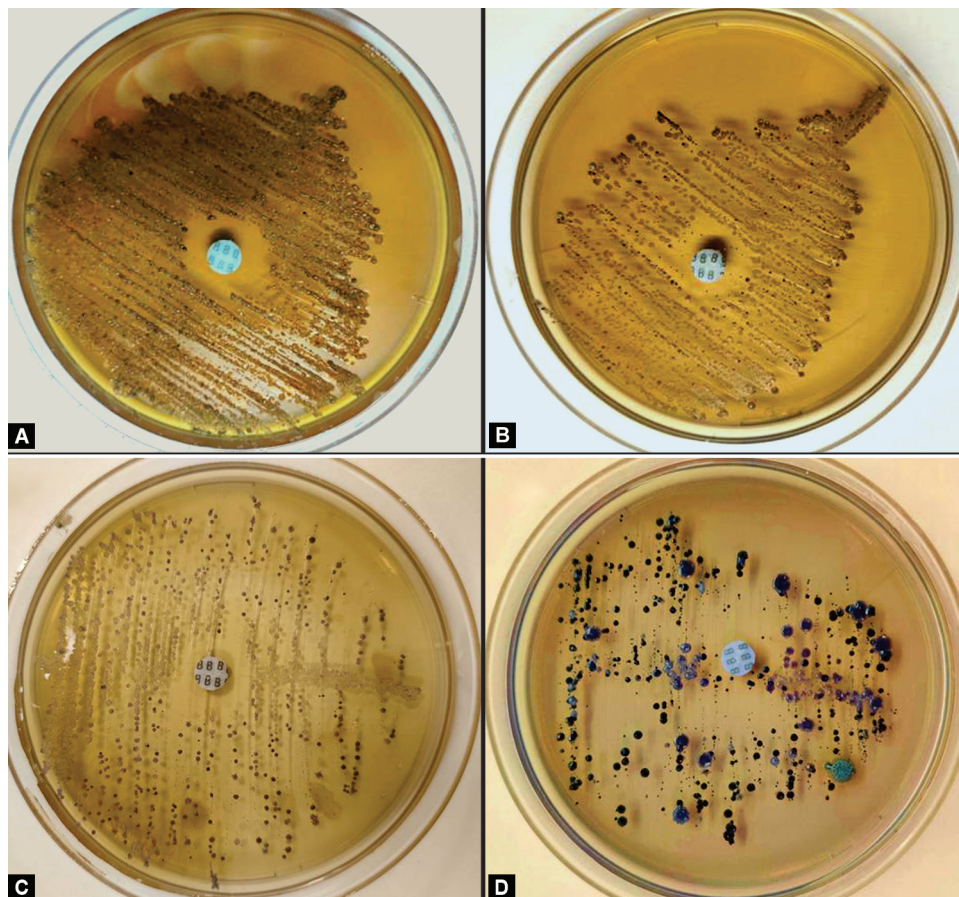


**Table 1:** Sample description according to the basic characteristics of the patients

Variable	Group I (Xylitol)	Group II (IgY + Xylitol)	Group III (Control)	p value
Age	8.60 + 1.336	8.65 + 1.388	8.85 + 1.460	0.699 <sup>a</sup>
• Mean + SD				
Sex	20	20	21	0.967 <sup>a</sup>
• Male (n)	20	20	19	
• Female (n)				
DMFT score	1.98 + 0.832	2.03 + 0.891	1.90 + 0.778	0.797 <sup>a</sup>
• Mean + SD				
Frequency of cleaning teeth	1.50 + 0.506	1.53 + 0.506	1.53 + 0.506	0.968 <sup>a</sup>
• Mean + SD				
Frequency of sweet consumption	2.00 + 0.816	2.03 + 0.862	1.93 + 0.859	0.860 <sup>a</sup>
• Mean + SD				

a = non-significant difference ( $p > 0.05$ )

SD = standard deviation

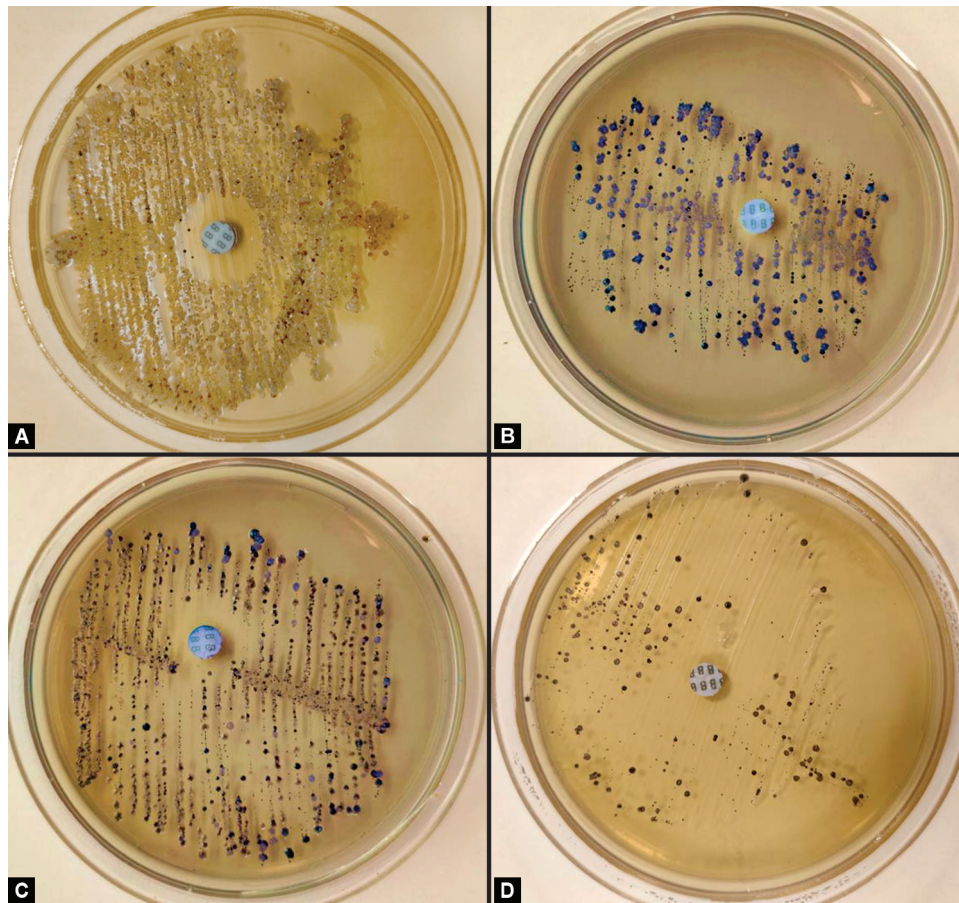
**Figs 1A to D:** *Streptococcus mutans* culture of Group I–Xylitol chewing gum

number of *S. mutans* CFUs/mL was seen in Group II (IgY + Xylitol) and least in Group III (Control) as plotted in Figure 4. "Pair-wise comparison using Mann Whitney U test" (Table 3) showed "highly significant" ( $p < 0.01$ ) reduction in number of *S. mutans* CFUs/mL between IgY + Xylitol vs Xylitol, Xylitol vs Control and IgY + Xylitol vs Control at 15 days to 3 months interval. Intragroup comparison using Friedman's test (Table 4) showed that both in Group I (Xylitol), Group II (IgY + Xylitol), and Group III (Control) there was significant reduction in the number of *S. mutans* CFUs/mL at 3 months interval as compared to baseline.

## DISCUSSION

In accordance to the last National Oral Health Survey (2002–2003) there has an alarming increase in incidence dental caries in 5–15 years age–group. This clearly indicates the challenging situation to be faced by a multitudinal country like India. Alternative modalities of preventing and treating this mammoth of a condition should be encouraged.

The American Academy Of Pediatrics recommends the consumption of chewing gums only above the age of 4 in order to



Figs 2A to D: *Streptococcus mutans* culture of Group II-IgY + Xylitol chewable tablet

Table 2: Intergroup comparison of *Streptococcus mutans* CFUs/mL of the three groups at various intervals

Groups	N	Mean	Standard deviation	Standard error	Median	Minimum	Maximum	Chi-square value	p value of Kruskal-Wallis ANOVA
Baseline	I	40	181,700.00	6034.941	954.208	181,000	171,000	31.795	0.503 <sup>a</sup>
	II	40	190,350.00	6911.714	1092.838	189,500	175,000		
	III	40	189,000.00	6872.465	1086.632	189,000	172,000		
	Total	120	187,016.67	7591.441	693.001	171,000	205,000		
15 days	I	38	168,105.26	5853.109	949.500	170,000	160,000	94.588	0.000 <sup>b</sup>
	II	38	150,842.11	7810.341	1267.005	152,000	133,000		
	III	38	187,078.95	7034.208	1141.099	186,000	169,000		
	Total	114	168,675.44	16,381.241	1534.244	133,000	197,000		
1st month	I	38	157,236.84	5257.860	852.938	158,000	150,000	100.515	0.000 <sup>b</sup>
	II	38	113,052.63	6084.750	987.077	112,500	104,000		
	III	38	186,710.53	7020.849	1138.932	186,000	169,000		
	Total	114	152,333.33	31,011.179	2904.463	104,000	197,000		
2nd month	I	38	146,263.16	4163.446	675.400	147,000	140,000	100.554	0.000 <sup>b</sup>
	II	38	103,789.47	3898.426	632.408	104,000	97,000		
	III	38	185,710.53	6476.185	1050.576	185,000	170,000		
	Total	114	145,254.39	33,960.365	3180.680	97,000	199,000		
3rd month	I	38	137,473.68	4150.785	673.346	138,000	130,000	100.589	0.000 <sup>b</sup>
	II	38	99,552.63	2668.104	432.824	100,000	94,000		
	III	38	185,500.00	5726.892	929.025	186,500	171,000		
	Total	114	140,842.11	35,587.752	3333.098	94,000	194,000		

a = non- significant difference ( $p > 0.05$ )

b = statistically highly significant difference ( $p < 0.01$ )

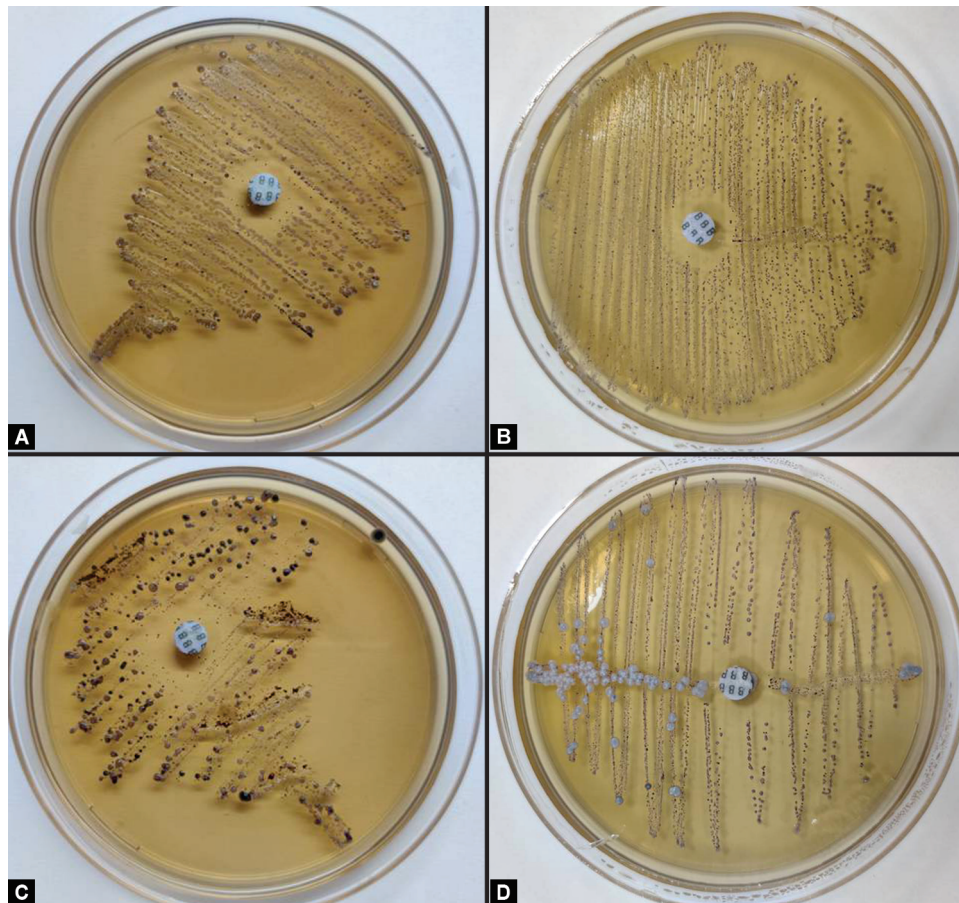


Fig. 3: *Streptococcus mutans* culture of Group III–Control (no intervention)

Table 3: Pair-wise comparisons of three study groups with respect to *Streptococcus mutans* level at baseline, 15 days, 1st month, 2nd month, and 3rd month

Time	Group	Versus group	Mann-Whitney U value	Z value	p value
Baseline	Xylitol	Xylitol + IgY	270.00	-0.106	0.570 <sup>a</sup>
	Xylitol	Control	324.00	-0.586	0.676 <sup>a</sup>
	Xylitol + IgY	Control	735.000	-0.627	0.531 <sup>a</sup>
15 days	Xylitol	Xylitol + IgY	50.500	-6.984	0.000 <sup>b</sup>
	Xylitol	Control	35.500	-7.140	0.000 <sup>b</sup>
	Xylitol + IgY	Control	0.500	-7.500	0.000 <sup>b</sup>
1st month	Xylitol	Xylitol + IgY	0.000	-7.506	0.000 <sup>b</sup>
	Xylitol	Control	0.000	-7.507	0.000 <sup>b</sup>
	Xylitol + IgY	Control	0.000	-7.505	0.000 <sup>b</sup>
2nd month	Xylitol	Xylitol + IgY	0.000	-7.511	0.000 <sup>b</sup>
	Xylitol	Control	0.000	-7.509	0.000 <sup>b</sup>
	Xylitol + IgY	Control	0.000	-7.508	0.000 <sup>b</sup>
3rd month	Xylitol	Xylitol + IgY	0.000	-7.515	0.000 <sup>b</sup>
	Xylitol	Control	0.000	-7.507	0.000 <sup>b</sup>
	Xylitol + IgY	Control	0.000	-7.514	0.000 <sup>b</sup>

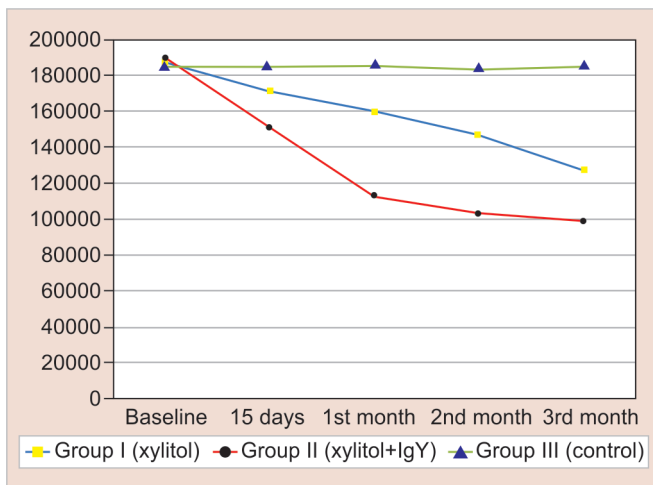
a = non-significant difference

b = statistically highly significant difference ( $p < 0.01$ )

**Table 4:** Intragroup comparison of the number of *Streptococcus mutans* CFUs/ml at various time intervals

	N	Mean	Standard deviation	Minimum	Maximum	Median	Chi-square value	p value of Friedman Test
Group I (Xylitol) baseline	38	181,736.84	6154.252	171,000	198,000	181,000.00	152.000	0.000 <sup>a</sup>
15 days	38	168,105.26	5853.109	160,000	180,000	170,000.00		
1st month	38	157,236.84	5257.860	150,000	166,000	158,000.00		
2nd month	38	146,263.16	4163.446	140,000	154,000	147,000.00		
3rd month	38	137,473.68	4150.785	130,000	146,000	138,000.00		
Group II (IgY + Xylitol) baseline	38	190,421.05	7027.481	175,000	205,000	189,500.00	152.000	0.000 <sup>a</sup>
15 days	38	150,842.11	7810.341	133,000	169,000	152,000.00		
1st month	38	113,052.63	6084.750	104,000	127,000	112,500.00		
2nd month	38	103,789.47	3898.426	97,000	112,000	104,000.00		
3rd month	38	99,552.63	2668.104	94,000	105,000	100,000.00		
Group III (Control) baseline	38	189,263.16	6856.381	172,000	199,000	189,000.00	25.968	0.000 <sup>a</sup>
15 days	38	187,078.95	7034.208	169,000	197,000	186,000.00		
1st month	38	186,710.53	7020.849	169,000	197,000	187,000.00		
2nd month	38	185,710.53	6476.185	170,000	199,000	185,000.00		
3rd month	38	185,500.00	5726.892	171,000	194,000	186,500.00		

a = highly significant difference ( $p < 0.01$ )



**Fig. 4:** Mean *Streptococcus mutans* counts of the three study groups at various time intervals

avoid the risk of choking.<sup>12</sup> In accordance to the above statement, children aged 6–12 years were enrolled in all the three groups.

Chewing gums prevent tooth decay by stimulating saliva, one of the most significant host factors that determine the occurrence of dental caries. Stimulated saliva has increased acid buffering capacity because of the enhanced bicarbonate concentration thereby elevating the plaque pH.<sup>13</sup> Saliva stimulated by chewing also leads to super saturation with respect to calcium and phosphorus that promotes enamel remineralization.<sup>14</sup>

Previous studies by Loesche showed a significant reduction in saliva and plaque levels of *S. mutans* in children following administration of 5 grams Xylitol/day for 4 weeks.<sup>15</sup> In the present study, the efficacy of lesser concentrations of Xylitol were evaluated, both the chewing gum "(Happydent White Xylit Chewing Gum™, Perfetti Van Melle Pvt Ltd, India)" 2 pellets twice daily and the chewable tablet (Nodecay™, Inzpera Healthsciences Ltd, India) two tablets per day both delivered approximately 1.6 grams Xylitol/day. In accordance to various literature studies<sup>13</sup> a chewing time of 5 minutes was considered. Since the maximum beneficial effect of chewing gums is suggested after meals in the present study also children were instructed to chew the gum and the tablet after meals.<sup>16</sup>

Xylitol is aptly called "magic bullet"<sup>17</sup> because of the numerous studies conducted in the past which have proved its significant anti-microbial effect against salivary *Mutans Streptococci*.<sup>18-20</sup>

It is nonfermentable by plaque bacteria and does not encourage bacterial growth. Xylitol neutralizes the plaque acids by production of ammonia and amino acids and promotes degradation of bacterial cell membrane by intracellular vacuole formation.<sup>17</sup>

Egg yolk IgY is well suited for per-oral immunotherapy as previous study on Anti *S. mutans* IgY spray application in adults resulted "significant decrease" in *S. mutans* colonies.<sup>8</sup> Tooth paste incorporated with anti *S. mutans* IgY lead to reduction of caries in deciduous teeth.<sup>8</sup> Nguyen et al. reported that lozenges containing IgY selectively suppressed oral colonization by *S. mutans*.<sup>21</sup> Hatta et al. evaluated that IgY rinses inhibited the adherence of *S. mutans* to saliva-coated hydroxyapatite discs.<sup>22</sup> Thus the present study was designed for evaluation of the additive benefits of both Xylitol and IgY on salivary *S. mutans* levels in children.

Passive immunization against dental caries using IgY derived from chicken is financially viable as large quantities of antibodies can be obtained with sustainable availability. Also, the purification procedures such as water dilution methods are simple, cheap and nontoxic.<sup>8</sup> Compared with vaccination, passive immunotherapy using IgY has distinct advantages<sup>21</sup> such as: highly specific, rapid, and localized action, safeguard against inflammation by virtue of its inability to interact with human complement system,<sup>23</sup> wider age range of applicability, and being nontoxic human diet.

IgY does not cause any systemic effects as it is precluded from the systemic circulation.<sup>24</sup> Also as poultry eggs are a part of our routine diet, they are generally considered safe. Allergic reactions may occur upon ingestion of egg white but these can be completely avoided with IgY as it is procured from the egg yolk that is rarely associated with allergies.<sup>9</sup> However for safety purpose, those children allergic to egg products were not enrolled into the study.

The results of the study had showed children belonging to Xylitol group (Group I) had "significant reduction" in the proportion of "*S. mutans*" when compared to the control group. This was in accordance to studies conducted by Makinen et al., Milgrom et al., Haresaku et al.<sup>25,26</sup> However adverse effects such as diarrhea and flatulence have been reported with increased dosage of xylitol.<sup>27</sup> Xylitol-resistant strains have been attributed to its extended usage.<sup>28-30</sup> Thus, it could be assumed that apart

from their individual benefits against *S. mutans*, pairing Xylitol with IgY helped overcome these limitations. Hence, the results of the study showed after just 15 days of use, the synergistic benefit of the combination of IgY, and Xylitol was evident by the maximum decrease in *S. mutans* counts in Group II (Nodecay™).

The advantage of using the combination of IgY and Xylitol (Nodecay™) was its availability in a chewable tablet form that not only cause topical release of IgY but also prevent recolonization of the tooth surface by virtue of its persistence in saliva. In the present study also, the decreased levels of *S. mutans* count in the combination group of IgY and Xylitol (Nodecay™) persisted for a period of three months beyond its interruption. Endang et al. in his animal study concluded IgY antibody incorporated in soybean milk led to reduction of *S. mutans* as well as persistence of the antibody in saliva.<sup>31</sup>

In the present study, a “no chewing gum control group” was preferred over placebo gums as they hardly cause any variations in *S. mutans* levels and also, they have a disagreeable taste posing difficulties in motivating the children to use the gums with similar frequency and duration.<sup>32,33</sup>

The limitation of the study could be a small sample size and a short follow up period. The formulation used in the present study is derived for egg yolk and many individuals prefer to follow a vegetarian or vegan diet that limits its use. Attempts could be made to harvest IgY antibodies from egg free sources to increase its acceptability among a wider population. Further studies are needed evaluating the long-term efficacy of IgY + Xylitol combination against salivary *S. mutans*.

## CONCLUSION

Based on the results of the study, it could be concluded that the combination of IgY + Xylitol when administered for 15 days had a significant benefit against “salivary *S. mutans*” when compared to Xylitol and control group. Passive immunization may be initiated as early as 19 to 30 months after birth (window of infectivity) to prevent colonization of primary dentition with *S. mutans* and prevent or delay the development of caries in permanent dentition. The need of the hour is translation of scientific evidences into clinical practice with the emphasis on ecological approaches to caries prevention cause after all “an ounce of prevention is worth a pound of cure.”

## CLINICAL SIGNIFICANCE

The novel combination of IgY and Xylitol has a potential preventive approach in comparison to most of the conventional approaches that are of treatment in nature. Passive immunization with IgY not only attempts to decrease the *S. mutans* count but also confers extended immunity by preventing recolonization of the tooth surface by persistence of the antibodies in saliva.

## MANUFACTURER NAME

Happydent White Xylit Chewing Gum™, Perfetti Van Melle Pvt Ltd, India.  
Nodecay™, Inzpera Healthsciences Ltd, India.  
Mitis Salivarius Bacitracin Agar with Potassium Tellurite medium (Himedia M259, India).

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