# Propylthiouracil (PROP) - A Tool to Determine Taster Status in Relation to Caries Experience, *Streptococcus Mutans* Levels and Dietary Preferences in Children

Priya Verma* / Vabitha Shetty** / Amitha M. Hegde***

*Purpose: Dental caries remains the single most common disease of childhood that is neither self-limiting nor amenable to short term pharmacological management. Hence, there is a need to identify and institute preventive measures for those children who are at a greater risk for developing dental caries to determine the prevalence of tasters and non tasters among the group of school aged children. To compare and contrast the prevalence of dental caries, S.mutans levels and dietary preferences in children with different genetic sensitivity levels to the bitter taste of PROP.*

*Method: A total no of 500 children belonging to the age group of 6-12 years of both sexes were recruited from A.B. Shetty Memorial Institute of Dental Sciences in Mangalore, India. PROP sensitivity test was carried out to determine the inherent genetic ability to taste a bitter or sweet substance. Estimation of Streptococcus mutans levels were done, a questionnaire was given to evaluate their dietary habits and the caries experience was recorded. Collected data were tabulated and subjected for statistical analysis using Pearson Chi – square test of significance.*

*Results: The results suggested that there was increase in the caries experience and S.mutans levels among the group of non tasters as compared to tasters. Tasters tended to be sweet dislikers and non tasters tended to be sweet likers. On the whole tasters had a healthier dentition as compared to non tasters.*

*Conclusion: The PROP test proved to be a useful tool in determining the genetic sensitivity levels of bitter taste. Knowledge of an individuals taste perception can help us in identifying the children who are at higher risk for dental caries.*

**Key words:** *PROP; Taste perception; Caries experience; Dietary preferences; S.mutans*

J Clin Pediatr Dent 31(2):113-117, 2006

## INTRODUCTION

Oral health is an important element of general health and well being. Although largely preventable, many children across the world still suffer from the pain, discomfort and the other ill effects associated with oral diseases. The most common chronic disease of childhood is dental caries.[1]

It remains the single most common disease of childhood that is neither self-limiting nor amenable to short term pharmacological management. More than 80% of the pediatric population is affected by dental caries by the age of seventeen.[2] Further studies have also shown that "dental caries" is a significant health problem for children and is disproportionately concentrated in children from low income households and ethnic minority groups.[2]

Several studies have indicated that children with high sugar intake have higher caries rates which is positively related to sweet score and total sugar exposure. A comprehensive review of the role of diet and dental caries reaffirmed that sucrose appears to be the most important dietary item associated with dental caries.[3]

Inherited behavior and taste thresholds may play an important role in the frequency of carbohydrate intake. Genetic sensitivity to taste may be associated with the preference for or rejection of some foods by children.[4]

PROP (6-n-propylthiouracil) is a pharmacological drug used in clinical practice for the treatment of Grave's disease (hyperthyroidism). Being extremely bitter, PROP can be tasted at a very low concentration and this bitter property of PROP has proved to be a useful tool in determining the genetic sensitivity levels to bitter and sweet taste.[5]

It may be hypothesized that a higher prevalence of dental caries would be observed among non taster children compared to children who are medium tasters or super tasters. And if this hypothesis holds true; then the knowledge of an individual's taste threshold will facilitate the identification of those children who are at a high risk for developing dental caries, thus initiating a primary prevention program for them.

*Dr.Priya Verma Post graduate student, Department of Pedodontics and Preventive Children Dentistry, A. B. Shetty Memorial Institute of Dental Sciences.

**Dr.Vabitha Shetty Reader, Department of Pedodontics and Preventive Children Dentistry, A. B. Shetty Memorial Institute of Dental Sciences.

***Dr.Amitha M. Hegde. Professor and Head of the Department,Department of Pedodontics and Preventive Children Dentistry, A. B. Shetty Memorial Institute of Dental Sciences.

All correspondence should be sent to: Dr.Amitha M. Hegde, Professor and Head of the Department, Department of Pedodontics and Preventive Children Dentistry, A.B. Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore-575018, Karnataka, India.

Fax no: 0824-2204572 \ 2224440

Email: amipedo@yahoo.co

Since most of the studies on taste and oral health have been conducted on older adults, there is a relative paucity of studies in the dental literature with respect to the relationship between oral health and taste in children. Hence, the purpose of the present study is to determine the prevalence of tasters and non-tasters among a group of school children, and to contrast the prevalence of caries experience, streptococcus mutans level and dietary preferences in children with different genetic sensitivity levels to the bitter taste of PROP.[6, 7, 8, 9]

## MATERIALS AND METHODS

### Source of data:

500 children randomly selected belonging to the age group of 6-12 years of both sexes who reported to The Department of Pedodontics and Preventive Dentistry, A.B. Shetty Memorial Institute of Dental Sciences, Mangalore were a part of this study.

### Exclusion Criteria:

- Children who are not falling under American Society of Anesthesiologists (ASA) physical status of I.
- Children with any unstable mental condition.
- Children under any medication and antibiotics three months before the study.

### Methodology:

**Preparation of the PROP Strips:** The pure sample of PROP was obtained from the pharmaceuticals (Macleod's, Mumbai, India) and the PROP strips were prepared in the N.G.S.M institute of Pharmaceutical Sciences, Mangalore. Whatt man filter paper was cut into 2x2cm size and sterilized in an autoclave at 121° c for 15 minutes. The sterilized strips were weighed and stored in the desiccator until they were used for further preparation.

6-n-propylthiouracil (10 mg/ml) was dissolved in 5ml of ethyl alcohol in a beaker. Ten previously cut and sterilized Whatt man filter paper strips were soaked in the above solution for one hour for the complete absorption of the drug. The strips were removed and were allowed to dry at room temperature. Approximately 1.6 mg of drug was impregnated on each strip.[10]

### PROP Sensitivity Test:

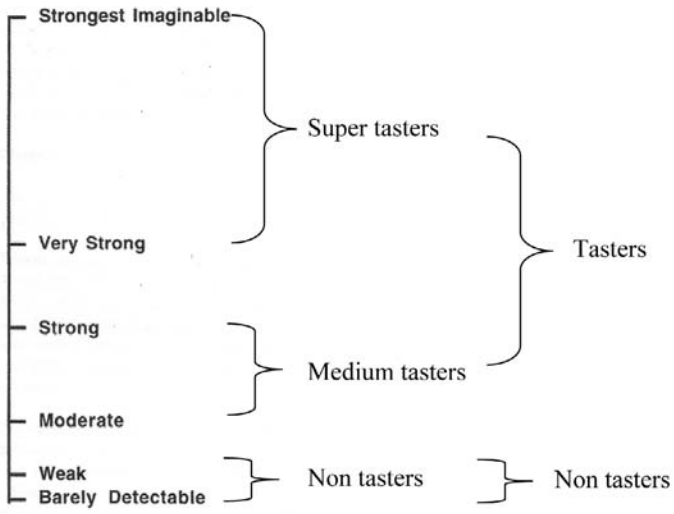
Once the strips were prepared, Prop sensitivity test was carried out on these children to determine the genetic sensitivity levels of bitter or sweet substances. These children were subdivided into two groups as PROP tasters and PROP non-tasters based on their ability to rate the intensity of bitter taste on a labeled magnitude scale (LMS)[11] as shown in Fig 1. The tasters were further classified as super tasters and medium tasters. PROP sensitivity test was carried out by placing a filter paper containing approximately 1.6 mg of 6-n-propylthiouracil on the dorsal surface of the anterior two-third region of the subject tongue for 30 sec.[12]

Estimation of Streptococcus mutans levels was done from 1 ml of stimulated saliva.

Evaluation of dietary preferences was done using a food preference questionnaire which was completed by the parents of the children to know their child's dietary habits[13] and their sweet, sour and strong taste preferences.

The caries experience (DMFT/dft index) was recorded using visible light, mouth mirror and CPITN probe.[14] The total DMFT/dft score of more than five was considered to have increased caries activity.[5]

**FIGURE 1:** Labeled Magnitude Scale (green scale)




## RESULTS

The subjects' place of residence could be characterized as poor construction and a lack of adequate sanitation conditions. These precarious conditions place this population far from ideal hygienic conditions and the maintenance of total health. Low socioeconomic and educational levels impair the maintenance of appropriate health conditions.

The thematic analysis of the interview was conducted for the classification of two groups: caries-active and caries-free children. The interviews carried out were planned based on each theme: behavior of the parent responsible for the child and knowledge and attitudes concerning oral health.

## DISCUSSION

Dental caries is one of the most prevalent infectious diseases to afflict mankind. The proportions of the world's population affected by dental caries increased dramatically once refined carbohydrates became available to the developed and the developing nations.[2]

Dental caries is dependent upon the critical interrelationship between susceptible host/tooth surface, specific oral bacteria, dietary carbohydrates and the balance between the cariogenic and non-cariogenic microbial population within saliva.[12]

It is also important to remember that one-fifth of the population accounts for about two-third of the total caries experience. It is difficult to identify the population who are at risk for developing dental caries with currently available screening methods. An expert panel reported that "effective dentistry requires early identification of children at higher risk for extensive caries so that they may receive early and intense preventive intervention."[15]

Studies have identified several indicators for an increased risk of dental caries e.g. cariogenic diet, high levels of cariogenic bacteria, low socio-economic status and influence of taste sensation, which may lead to preference, or rejection of food.[12]

Hence the present study was carried out to determine the relationship between caries experience, Streptococcus mutans levels, dietary preferences and different genetic sensitivity levels among the school children.

Of the 500 children who participated in this study 66.6% were tasters and 33.4% were non-tasters. This was in accordance with Brent.P.J.Lin, where the study was conducted on children and the number of non-tasters were found to be significantly lower (11%) than super tasters.[12]

The labeled magnitude scale (LMS) was used to measure the intensity of bitter taste of PROP. This scale has six categories with each one having a numerical value. The value increases as the intensity increases and the child was asked to rate his intensity as shown in Fig 1.

The children who were in the super taster and non-taster category could be identified easily as they would either find the taste of PROP extremely bitter or absolutely tasteless "as good as an ordinary paper" respectively but the child falling into a medium category where it was neither too strong nor too weak were difficult to categorize, hence the medium taster group contains both strong and moderate readings. This could also explain the comparable results found in the medium taster group with the super taster and the non-taster group occasionally.[16,17]

The overall caries experience in the present study group (mean DMFT/dft) was significantly higher for non-tasters as compared to tasters. Brent. obtained the similar results.[12] When the decayed, missing and filled groups were analyzed individually in all three dentition, the decayed group was found to be higher in non taster group irrespective of the type of dentition which was highly significant. The increased caries experience could be due to the increased consumption of sugar and sugar containing food by the non taster children.

The Male, Female ratio of tasters and non-tasters suggest that higher prevalence of females as tasters in our study, this was however not statistically significant. The findings were in accordance to A. Drewnowski and Duffy *et al.*[18,19]

Dietary preferences in the two groups suggested that 40% of the populations among the total population of tasters were sweets dislikers; while in the non-tasters group only 29.4% of the population disliked sweets and 41.2% preferred sweets frequently. High perception to bitter substances among the group of tasters leads to the dislike of sweet substances. Thus the data recorded in the study reveals that PROP non-tasters tended to be "sweet-likers" & PROP tasters tended to be "sweet-dislikers."

This could also be due to the number of distribution of fungiform papillae on the tongue which are present in high numbers in the anterior third, on the sides and the tip of the tongue. The filiform papillae are the most numerous in number and are distributed across the tongue but have no taste function. The number of fungiform papillae is related to genetic variation in the ability to taste. Tasters are shown to have a higher growth of fungiform papillae as compared to non-tasters as shown in Fig 2. The anatomical data also revealed that the distribution of the number of fungiform papillae and taste buds are said to be more in females thus making a majority in the group of super tasters.[17] We also got similar results in concurrence with other studies.[18,19]

Bartoshuk *et al* found that the bitter taste of saccharine, potassium chloride, sodium benzoate and potassium benzoate are greater for taster than for non-tasters.[18] Studies have also shown that sucrose, saccharin and neohesperidine dihydrocalcone were sweeter to tasters than to non-tasters.[20] Ankiler et al stated that genetic sensitivity to bitter taste might be associated with the preference for or rejec-

**FIGURE 2:** The Number of Fungiform Papillae is Directly Related to the Genetic Variation in the Ability to Taste

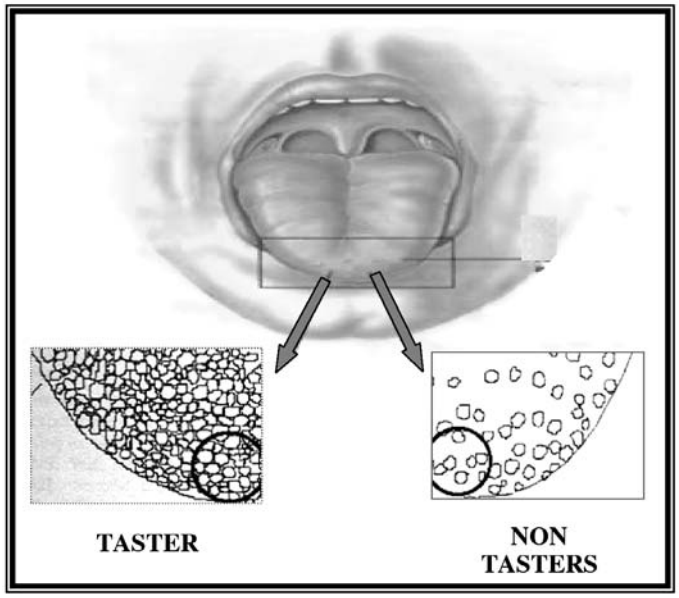



**TABLE 1:** types of tasters based on prop test

| PROP status | | Frequency | | Percentage | |
|---|---|---|---|---|---|
| Tasters | Super tasters | 174 | | 34.8% | |
| | Medium tasters | 159 | **333** | 31.8% | **66.6%** |
| Non tasters | Non tasters | **167** | | | **33.4%** |
| Total | | **500** | | | **100.0%** |

**TABLE 2:** mean dmft/dft and standard deviation in permanent, mixed and primary dentition

| dentition | | GROUP | N | Mean | Std. Deviation | Z |
|---|---|---|---|---|---|---|
| Permanent | DMFT | Taster | 23 | 1.1304 | 1.65980 | 3.46800 |
| | | Non taster | 10 | 5.4000 | 2.87518 | p=.001 vhs |
| | D | Taster | 23 | 1.1304 | 1.65980 | 2.61100 |
| | | Non taster | 10 | 3.0000 | 2.00000 | p=.009 hs |
| | M | Taster | 23 | .0000 | .00000 | 4.04400 |
| | | Non taster | 10 | 2.4000 | 2.06559 | p=.001 vhs |
| | F | Taster | 23 | .0000 | .00000 | .00000 |
| | | Non taster | 10 | .0000 | .00000 | p=1 ns |
| Mixed | DMFT | Taster | 278 | 1.0360 | 1.66037 | 2.00300 |
| | | Non taster | 131 | 1.6489 | 2.83908 | p=.045 sig |
| | D | Taster | 278 | .8417 | 1.53307 | 2.06800 |
| | | Non taster | 129 | 1.2868 | 2.10726 | p=.039 sig |
| | M | Taster | 278 | .0216 | .14558 | 1.38900 |
| | | Non taster | 131 | .1221 | .66821 | p=.165 ns |
| | F | Taster | 278 | .1691 | .64448 | .16500 |
| | | Non taster | 131 | .2443 | .84208 | p=.869 ns |

| dentition | | GROUP | N | Mean | Std. Deviation | Z |
|---|---|---|---|---|---|---|
| Mixed | dft | Taster | 278 | 1.9712 | 2.61885 | 2.22500 |
| | | Non taster | 131 | 2.5267 | 2.80749 | p=.026 sig |
| | d | Taster | 276 | 1.7355 | 2.55107 | 2.40100 |
| | | Non taster | 131 | 2.2977 | 2.72790 | p=.016 sig |
| | f | Taster | 276 | .2355 | .70760 | .08100 |
| | | Non taster | 131 | .2443 | .72421 | p=0.936 ns |
| Primary | dft | Taster | 29 | 3.1724 | 2.64668 | 1.97800 |
| | | Non taster | 29 | 4.7241 | 3.21710 | p=.048 sig |
| | d | Taster | 29 | 3.0345 | 2.70559 | 2.07100 |
| | | Non taster | 29 | 4.7241 | 3.21710 | p=.038 sig |
| | f | Taster | 29 | .1379 | .51576 | 1.42700 |
| | | Non taster | 29 | .0000 | .00000 | p=0.154 ns |

**TABLE 3:** dietary preferences among the tasters and the non tasters

| DIETARY PREFERENCES | | TASTER GROUP | | |
|---|---|---|---|---|
| | | Taster | Non taster | Total |
| Does Not Prefers | | 132 | 50 | 182 |
| | | 40.0% | 29.4% | 36.4% |
| Prefers Occasionally | | 109 | 50 | 159 |
| | | 33.0% | 29.4% | 31.8% |
| Prefers Frequently | | 89 | 70 | 159 |
| | | 27.0% | 41.2% | 31.8% |
| Total | Count | 330 | 170 | 500 |
| | % | 100.0% | 100.0% | 100.0% |

a. X2=11.039 p=.001 vhs

**TABLE 4:** *S. mutans* levels among the tasters and non tasters

| Sl. no | S.mutans count | | Risk level | Group | | Total |
|---|---|---|---|---|---|---|
| | | | | Taster | Non-taster | |
| 1 | Low counts | $10^3$ CFU/ml | Low risk | 68 20.6% | 16 9.4% | 84 16.8% |
| 2 | | $10^4$ CFU/ml | | 78 23.6% | 33 19.4% | 111 22.2% |
| 3 | Intermediate counts | $10^5$ CFU/ml | At risk | 108 32.7% | 61 35.9% | 169 33.8% |
| 4 | | $10^6$ CFU/ml | | 74 22.4% | 60 35.3% | 134 26.8% |
| 5 | High counts | $10^7$ CFU/ml | High risk | 2 0.6% | 0 0% | 2 .4% |
| Total | | Count % | | 330 100.0% | 170 100.0% | 500 100.0% |

a.$X_2$=17.566 p=.001vhs

tion of some foods by children.[9]

Super tasters or sweet dislikers might avoid sweet food because their oral sensations are too intense and thus less pleasant to accept the intensely bitter, strong and sweet substance thus making super tasters less prone to decay. However, it has also been stated that the bitter substances contain antioxidants, which helps in preventing diet related diseases like cancer.[21] Thus super tasters are at higher risk of developing such diseases. The ability to taste bitter thiourea compounds such as phenylthiocarbamide (PTC) and its chemical derivatives such as 6-n-propylthiouracil (PROP) is an inherited trait. Food preferences can be better characterized when assessed in conjunction with personal characteristics such as cultural and familial experiences, personality factors and attitude about nutrition and health.[21]

In the present study it was observed that *S. mutans* levels increased from tasters to non-tasters thus placing them at higher risk of developing dental caries. However one study has also suggested that a high intake of sweetened baked food might be a determinant of caries prevalence in children and high Streptococcus count.[22] Whereas others have suggested that salivary concentration of *mutans* and lactobacilli and frequency of ingestion of confectionary were independently and positively related to caries experience.[7]

Thus a strong positive correlation was established in the present study between genetic sensitivity levels of an individual, caries experience, dietary preferences and *S. mutans* level. Hence, it can now be stated that the PROP can be used as a useful tool in determining the genetic sensitivity levels of an individual and the knowledge of an individuals taste perception can help us in identifying the children who are at higher risk for developing dental caries.

Need for a study of a larger group is required with the equal population of males and females to come to a confirmed report on the taster's status. Children of older ages can be included in the study due to the more developed taste perception and development of dietary preferences with age. Further investigations are also required using a more appropriate scale as well as other correlating factors such as behavior, weight, salivary flow and socio-economic status.

## CONCLUSION

1. A strong positive correlation was established between genetic sensitivity levels of an individual, caries experience, dietary preferences and *S. mutans* levels.

2. PROP can be used as a useful tool in determining the genetic sensitivity levels of an individual by conducting a small chair side test which can help us in identifying the children who are at higher risk for dental caries.

## ACKNOWLEDGEMENTS

*Prof. (Dr.) R. Narayana Charyulu.* Professor, Dept. of Pharmaceutics N.G.S.M Institute of Pharmaceutical Sciences Mangalore. Prof (Dr). Krishna Prasad, Professor and Head & his team members, Department of microbiology, K. S. Hegde Academy of Medical Sciences, Mangalore. Dr. Ashish Murtangeshwar & staff of Macleod's Pharmaceuticals, Mumbai, for sponsoring 6-n- propylthiouracil to carry out this study.

## REFERENCES

1. Edelstein BL, Douglass CW, Dispelling the myth that 50% of U.S school children have never had a cavity .1985; 110: 522-30.
2. Socio-demographic distribution of pediatric dental caries: NHANES III, 1988-1994. JADA September 1998; Vol 129: 1229-1238.
3. Habibian M, Roberts G, Lawson M. Dietary habits and dental health over the first 18 months of life. Community Dent Oral Epidemiology. 2001; 29:239-46.
4. Downer MC. Caries experience and sucrose availability: an analysis of the relationship in the United Kingdom over 50 yrs. Community Dent Health.1999; 16:18-21Brent P-J Lin. Caries experience in children with various genetic sensitivity levels to the bitter taste of PROP, Pediatr Dent -2003; 25:1: 37-42.
5. Lehl G, Bansal K, Sekhon R. Relationship between cariogenic diet and dental caries as evaluated from a 5-day diet diary in 4-12 yr old children. J Indian Soc Pedod Prev Dent.1999; 17:119-121
6. Mazengo MC, Tenovuo J, Hausen H. Dental caries in relation to diet, saliva, and cariogenic microorganism in Tanzanians of selected age groups. Community Dent Oral Epidemiology.1996; 24:169-174.
7. Beighton D, Adamson A, Rugg-Gunn A. Associations between dietary intake, dental caries experience, and salivary bacterial levels in 12 year old English school children. Arch Oral Biol.1996; 41:271-280.
8. Eronat N, Koparal E. Dental caries prevalence, dietary habits, tooth brushing, and mother's education in 500 urban Turkish children. J Marmara Univ Dent Fac 1997; 2:599-604.
9. Anliker JA, Bartoshuk LM, Ferris AM, Hooks LD. Children's food preferences and genetic sensitivity to the bitter taste of PROP. Am J Clin Nutr. 1991, 54:316-320.
10. Zhao L, Kirkmeyer SV, Tepper BJ. A paper screening test to assess genetic taste sensitivity to 6-n-propylthiouracil. Physiol Behav. 2003;

78:625-633.
11. Green BG, Shaffer GS, Gilmore MM.A semantically Labeled Magnitude Scale of oral sensation with apparent ratio properties. Chem. Senses.1993; 18: 683-702.
12. Brent P-J Lin. Caries experience in children with various genetic sensitivity levels to the bitter taste of PROP, Pediatr Dent -2003; 25:1: 37-42.
13. Per Axelson. Diagnosis and risk prediction of dental caries. Vol- II quintessence publishing co.inc, Sweden; 156-168.
14. World Health Organization. Oral health survey; basic methods.4th Ed Geneva: World Health Organization; 1997.
15. NIH Consensus development conference. Diagnosis and management of dental caries throughout life, new release. More rigorous studies needed to advance emerging dental caries diagnostic and management strategies, says NIH consensus panel. Pediatr Dent. 2001; 23:123-124.
16. Julie Peterson, Megan Philips: salt liking and Intake: potential relation ships with genetic variations in taste. http://ugradresearch.uconn.edu/fur2000.html.
17. Grushka M, Bartoshuk LM Oral Dysesthesias and Burning Mouth Syndrome: Taste is a piece of the puzzle. The Canadian Journal of Diagnosis, 2003 June; 99-109.
18. Bartoshuk LM, Duffy VB and Miller IJ. PTC/PROP Tasting: Anatomy, Psychophysics, and Sex Effects. Physiol Behav 1994; Vol. 56, No. 6: 1165-1171.
19. Drewnowski A, Henderson SA & Barratt-fornell A. Genetic Sensitivity to 6-n-Propylthiouracil and Sensory Responses to Sugar and Fat Mixtures. Physiol Behav. 1998; Vol 63, No.5: 771-777.
20. Yackinous C, Guinard JX. Relation between PROP taster status and fat perception, touch, and olfaction. Physiol Behav. 2001; 72: 427-431.
21. Ullrich NV, Touger-Decker R, O'sullivan-Maillet J, Tepper BJ. PROP Taster Status and Self-Perceived Food Adventurousness Influence Food Preferences. J Am Diet Assoc. 2004; 104:543-549.
22. Closas RG, Closas MG, Majem LS. A cross-Sectional study of dental caries, intake of confectionary and foods rich in starch and sugar, and salivary counts of streptococcus mutans in children in Spain. Am J Clin Nutr. 1997; 66:1257-1263.