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Assessment of Plaque pH after Oral Rinsing with Four Customary Used Types of Complementary Infant Formula

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ABSTRACT

Background: Complementary infant formulas are the second most important sources of nutrition for neonates after breast milk. Considering the cariogenic potential of infant formulas, selection of these nutritive sources should be safe to reduce the risk of baby bottle syndrome in newborns. The present study aimed to estimate the plaque pH changes after rinsing with four customary used types of complementary infant formula.

Methods: An in-vivo, in-vitro study was conducted on five healthy neonates aged 12-18 months to assess the plaque pH changes caused by rinsing with four different types of complementary infant formula, including Rice and Milk Cerelac, Wheat and Milk Cerelac, Banana and Milk Humana, and Peach and Milk Humana. Data analysis was performed in SPSS version 17 using paired t-test to compare the pH changes associated with each formula. In all the statistical analyses, P-value of less than 0.01 was considered significant.

Results: All the formulas significantly reduced the plaque pH to less than the pre-rinse pH. However, the plaque pH decreased to less than the critical pH level (<5.7), particularly in the infants using the Rice and Milk Cerelac formula.

Conclusion: According to the results, rinsing with the Rice and Milk Cerelac formula reduced the plaque pH value more than the other formulas. Therefore, it seems that complementary infant formulas could decrease the plaque pH and play a key role in the development of caries in neonates depending on the ingredients.

Keywords: Cariogenic diet, Complementary feeding, Dental caries resistance, Dental decay, Prevention

Introduction

Over the past decade, complementary foods have been formulated and recommended as a key source of nutrition for infants in order to improve their essential nutritive agents. This recommendation is mainly due to the low iron intake and iron bioavailability, especially in developing countries (1). In addition, one of the principles for the complementary feeding of breastfed infants proposes that complementary foods should be introduced at the age of 4-6 months (1, 2). Since human milk contains a small quantity of highly bioavailable iron, ongoing research suggests the consumption of complementary foods and cereals in addition to breast milk in order to compensate for the insufficiency of iron in newborns (3).

On the other hand, there has been growing concern among children's dental professionals regarding the cariogenic potential of various foods (4, 5). Assessment of food cariogenicity involves several basic factors, including the host, diet (6), and microorganisms available in the plaque, which ferment carbohydrates and produce acids (7, 8). In addition to the presence of sucrose, other factors (e.g., frequency of sugar consumption, salivary retention time, and the amount of produced

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acid) may affect caries induction (9).

Some studies have demonstrated that milk, specially its casein component in infant formulas, could can protect the enamel from dissolution in acids (10, 11). Therefore, it could be inferred that the ingredients of other complementary foods than milk may exert more effective cariogenic effects. Furthermore, the studies by Mundorff et al. and Bibby et al., which focused on enamel demineralization, indicated that the fermentation of foods was mainly influenced by flavoring agents and other additive components (12, 13).

Considering the increased consumption rate of complementary infant foods (14), it is of paramount importance to realize the potential of caries production in these nutritional sources, which in turn enables clinicians and parents to recognize and select foods with less cariogenicity. Preventing of early childhood caries is a matter of concern if we consider difficultly in management of children with early childhood dental carries in dental settings(15).

To the best of our knowledge, no documented studies have focused on the issue of complementary foods for infants in Iran. The present study aimed to compare the cariogenicity of various complementary formulas in terms of the changes in the plaque pH. Moreover, we evaluated the cariogenicity of these complementary infant formulas based on their nutritional contents.

Methods

This in-vivo, in-vitro study was conducted on five healthy infants aged 12-18 months.

Exclusion criteria were the neonates receiving antibiotic therapy within the past six weeks, history of allergy to milk, and use of medications affecting the salivary flow within at least two weeks prior to sampling.

Informed consent was obtained from the parents of the infants for participation in the study, and the study protocol was approved by the Institutional Ethics Committee. The parents were asked not to brush the infants' teeth for a minimum of one day before the study and not to feed the infants for at least one hour prior to sampling.

Four commercially available formulas, including Rice and Milk Cerelac, Wheat and Milk Cerelac, Banana and Milk Humana, and Peach and Milk Humana, were prepared in accordance with the instructions of the manufacturers. In addition, a 10% sucrose solution was prepared by dissolving 50 grams of sucrose in distilled water to the final volume of 500 milliliters. Each solution was marked with a number and randomly selected for the participants. The researcher was blinded to all the procedures throughout the study.

Supragingival plaque was sampled from the buccal surfaces of the maxillary teeth before and after a one minute of rinsing with five milliliters of each of the four complementary formulas. The microbial plaque was dissolved in 50 microliters of deionized water. In the present study, the positive control group was a 10% sucrose rinse, and the negative control group was the solution with the pre-rinse plaque.

The pH of each sample was measured using a digital pH-meter (Metrohm, model: Electrode-744, Switzerland). The measurements were performed for the pre-rinse and post-rinse plaque solutions at 10-minute intervals per one hour. The lowest pH in the one-hour post-rinse period was recorded as the minimum pH for each group. Declined pH was defined as the difference between the initial pre-rinse plaque pH and minimum post-rinse plaque pH.

Data analysis was performed in SPSS version 17 (IBM, Chicago, IL, USA) using paired t-test to compare the pH changes caused by each formula with the mean pre-rinse plaque pH, as well as the pH values associated with different formulas. In all the statistical analyses, P-value of less than 0.01 was considered significant.

Results

Mean pre-rinse pH value in all the samples was 6.7±0.33, and the results showed that all the infant formulas could significantly decrease the plaque pH (Table 1). In addition, the mean minimum post-rinse plaque pH was significantly lower in the infants fed with the Rice and Milk

Table 1. Minimum Post-Rinse pH Plaque Associated with Various Formulas in One Hour

Formula Solution	Mean pH	SD	P-value
Peach and Milk Humana	5.88	0.23	<0.001
Wheat and Milk Cerelac	5.76	0.32	<0.001
Banana and Milk Humana	5.63	0.43	<0.001
Rice and Milk Cerelac	5.50	0.23	<0.001
10% Sucrose	5.42	0.32	<0.001

Comparison with mean pre-rinse (mean: 6.7±0.33) according to paired t-test; N=5

Table 2. Reduction of Plaque pH Associated with Various Formulas

Formula	Mean pH Reduction	SD	P-value
Peach and Milk Humana	0.87	0.43	<0.001
Wheat and Milk Cerelac	0.93	0.23	<0.001
Banana and Milk Humana	1.04	0.32	<0.001
Rice and Milk Cerelac	1.14	0.13	<0.001
10% Sucrose	1.32	0.21	<0.001

Comparison with mean pre-rinse (mean: 6.7±0.33) according to paired t-test; N=5

Cerelac compared to the post-rinse plaque pH of the other formulas. The mean minimum pH of different formulas is presented in Table 1.

Similarly, the Rice and Milk Cerelac caused a more significant plaque complex pH reduction compared to the other complementary formulas, followed by Banana and Milk Humana, Wheat and Milk Cerelac, and Peach and Milk Humana, respectively. Reduction of the plaque pH caused by different formulas is shown in Table 2.

Discussion

It is generally accepted that the nutrients with more acid production after fermentation have a higher cariogenicity potential. The methods used to measure plaque pH values after food consumption have been applied in several studies due to their ability to determine the cariogenic potential of various foods (6). According to the results of the current research, all the complementary infant formulas could significantly decrease the mean pH value of the microbial plaque complex (Table 1), with Rice and Milk Cerelac causing the highest reduction in the plaque complex pH, followed by Banana and Milk Humana, Wheat and Milk Cerelac, and Peach and Milk Humana, respectively (Table 2). Furthermore, rinsing with the Rice and Milk Cerelac was associated with a critical pH in the microbial plaque, which was considered to be clinically significant (Table 1). In the present study, the pH of less than 5.7 was defined as the critical pH in line with the study by Harper et al. (16).

In the current research, the level of the pH reduction caused by the complementary formulas could not be predicted in terms of the type of the complementary infant foods, which is consistent with the results obtained by Curzon et al. and Pollard et al. (17, 18).

According to the literature, dried fruits are potentially more cariogenic compared to fresh fruits since the drying process breaks down the cellular structure of the fruit, thereby releasing a higher concentration of free sugars. Consequently, fruit-based complementary could be regarded as cariogenic nutrients (10), and the fruits used in such complementary foods may have a higher cariogenic potential compared to fresh fruits. Our findings suggested that banana might be more acidogenic compared to peach, while in the study by Lee et al., banana was reported as one of the most cariogenic fruits (12) with the same cariogenic potential as 10% sucrose (19).

Cariogenicity of the foods is often determined based on their contents, such as the levels of carbohydrate, calcium, phosphorus, lipids, and protein, which could be found in fruits and cereals (20, 21). This is compatible with the association of pH decrement and the ionic contents of the complementary foods used in the current research. Correspondingly, higher carbohydrate contents are associated with the more significant reduction of pH (10), which is in line with our findings regarding the higher carbohydrate contents in rice and banana.

On the other hand, the results of the present study showed that the calcium and phosphorus contents of complementary foods could prevent the pH decrement in the samples, which is consistent with several studies in this regard (10, 22, 23). In congruence with the findings of the previous studies, the presence and levels of protein and casein in foods may enhance the buffering capacity of plaque-saliva complex, which could also contribute to preventing pH reduction (23, 24). Conversely, the lipid content of foods has been shown to exert anti-cariogenic effects (24, 25). According to the results of the current research, high calcium and phosphorus contents in the peach and milk complementary formula, as well as their high protein content, could be associated with their lower acidogenicity compared to the other complementary foods (Table 3).

Rice is considered to be one of the best fermentable cereals producing alcohol and acids from its various carbohydrates (26). As a result, the high cariogenecity of rice could be attributed to the nature and amount of its fermentable carbohydrates.

Table 3. Levels of Various Ingredients (/100 g Powder) in Four Complementary Infant Formulas

Complementary Infant Formula	Carbohydrates (g)	Calcium (mg)	Phosphorus (mg)	Protein (g)	Lipids (g)
Rice and Milk Cerelac	68	350	290	14	9
Wheat and Milk Cerelac	67	410	460	15	10
Milk and Banana Humana	62	400	240	17	14
Milk and Peach Humana	53	610	534	26	9

Conclusion

According to the results, rinsing with the Rice and Milk Cerelac reduced the plaque pH value more significantly compared to the other complementary infant formulas. However, the base of complementary foods (cereals or fruits) could not definitively determine their acidogenicity. Therefore, it seems that the ingredients and contents of complementary foods may be a more reliable index to verify their acidogenicity.

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Conflicts of interest

None declared.

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