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COMPARISON OF DIETARY INTAKES AND FERMENTED FOOD CONSUMPTION IN PATIENTS WITH AND WITHOUT PERIODONTAL DISEASE

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Abstract: Lack of certain nutrients and foods in the diet may negatively affect oral health. Therefore, nutrition may play an important role in maintaining oral health. This study aimed to evaluate and compare the nutrient intakes, consumption of food groups and some fermented foods of individuals with periodontal disease and health. Thirty-one patients with periodontitis, 31 with gingivitis who applied to the periodontology clinic and 31 individuals of similar age and gender without periodontal disease were included in this study. Plaque, gingival indices, bleeding on probing, periodontal pocket depth, and clinical attachment level were evaluated. To determine individuals' daily energy, nutrient intakes, and consumption of food groups, 24-hour food consumption records were kept for three consecutive days by the nutritionist. Data on individuals' frequency and amount of consumption of some fermented products were recorded, considering the foods available in our culture and the market. Totally, 34 men and 59 women participated in the study. Mean energy intake was similar among groups. Energy from total dietary fat (%, P=0.042), saturated fatty acid (P=0.002), and short and medium chain fatty acids (P=0.003), consumption of dairy products (except cheese) (P=0.009), cheeses (P=0.025), coffee (P=0.036), whole-grain bread (P=0.010) and kefir (P=0.013) were different among individuals with periodontal disease and periodontal health. In conclusion, nutrition may have an impact on periodontal health and disease.

Keywords: Dietary fat intake, Fermented foods, Periodontal health, Periodontal disease

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1. Introduction

Periodontal disease and condition are categorized as periodontal health, periodontal diseases and conditions, or periodontitis or other conditions affecting the periodontium, according to the 2017 classification (Papapanou et al., 2018). Gingival health can be seen in intact and reduced periodontium without clinical attachment loss or bone loss. Gingivitis is a clinical diagnosis initiated by microbial dental plaque accumulation and inflammation involving the gingiva but not extending to the periodontal attachment. Clinical symptoms of inflammation are erythema, edema, pain, heat, and loss of function (Chapple et al., 2018). Periodontitis is a chronic multifactorial inflammatory disease associated with dysbiotic plaque biofilms and characterized by the progressive destruction of tooth-supporting tissues. The primary features are loss of periodontal tissue support, periodontal pocket formation, and gingival bleeding, as manifested by clinical attachment loss and radiographically assessed alveolar bone loss (Papapanou et al., 2018). Dental plaque is a community of microorganisms embedded in a host and bacterial polymer matrix that exists as a biofilm on the tooth surface (Marsh, 2006). *Porphyromas gingivalis (P. gingivalis), Bacteroides forsythus (B. Forsythus),* and *Treponema denticola (T. denticola)* can be detected in supragingival microbial dental plaque specimens from both healthy and periodontitis patients (Ximénez-Fyvie et al., 2000). *Streptococcus spp. (S. sanguis, S. intermedius, S. oralis* and *S. anginosus), Actinomyces spp. (A.viscosus, A. naeslundii), Eubacterium nodatum* and *Parvimonas micra* are associated with gingivitis (Newman et al., 2006).

Nutrition is an essential adjustable parameter that can significantly impact oral health. Improper nutrition may negatively affect oral health, and inadequate oral health may affect dietary intake, leading to malnutrition. Therefore, oral health is important in maintaining good nutrition (Martinon et al., 2021). Excessive sugar consumption or refined carbohydrates has promoted dysbiosis of the microbiota, which induces and causes an inflammatory reaction (Bosma-den Boer et al., 2012).

Sugar may cause plaque formation and bacterial growth, leading to periodontitis (Keukenmeester et al., 2014).

Deficiencies of vitamins A, C, E, folic acid, and calcium are associated with periodontal disease (Gondivkar et al., 2019; Varela-López et al., 2018). Moreover, several potential health benefits have been attributed to fermented foods and beverages in recent years, as they contain biologically active peptides, vitamins, and other compounds produced by the bacteria responsible for fermentation. Fermented foods have antioxidant, antimicrobial, anti-fungal, anti-inflammatory, anti-diabetic, and anti-atherosclerotic properties (Şanlier et al., 2019). It has been reported that regular consumption of foods with high lactic acid content and dairy products positively affects periodontal health (Shimazaki et al., 2008). In addition, the total flavonoid content of the diet (Sparrow et al., 2020), the type of protein source (Eberhard et al., 2022), the diet pattern according to the presence of healthy or unhealthy foods in the diet (Costa et al., 2022), having high vitamin-mineral and fiber content (Sinead Watson et al., 2022) may be associated with periodontal health. On the other hand, in a large cohort study, Western-style dietary components were compared with individuals who preferred relatively healthier diets. It was concluded that diet was not associated with periodontitis risk (Alhassani et al., 2021). In another study, it was shown that the Mediterranean-style diet is not associated with periodontal disease (Iwasaki et al., 2021). The relationship between dietary components to periodontal health is unclear. Thus, this study aimed to evaluate and compare the nutrient intake, consumption of food groups and some fermented foods of individuals with periodontal disease and periodontal health.

2. Materials and Methods

2.1. Study design and sample

Ninety-three systemically healthy individuals aged 18-65 who applied to the Gazi University Faculty of Dentistry for treatment were included in this study. To test the statistical significance of the differences between gingivitis, periodontitis, and periodontal health groups' one-way analysis of variance was performed at an effect size of 0.35, 85% power, and 5% error level and 31 cases were included in each group.

The study data were collected through a questionnaire prepared by the researchers. The survey form consisted of three sections, in which data on the general characteristics of individuals, food consumption forms, and the frequency and amount of fermented food consumption are recorded.

2.2. Selection of Participants

Patients with three teeth other than 20-year-old teeth in each jaw were included in the present study. Pregnancy, lactation, patients with an acute oral lesion or necrotizing ulcerative periodontitis, history of diabetes, rheumatic fever, lung and kidney disorders, and use of drugs that affect periodontal tissues (regular use of antibiotics, anti-inflammatory and mouthwashes), patients who smoke, or patients who did not quit until last year were excluded.

Plaque (Silness and Loe, 1964), gingival indices (Loe and Silness, 1963), bleeding on probing (Ainamo and Bay, 1975), periodontal pocket depth, and clinical attachment level UNC-15 periodontal probe (Hu-Friedy®, Chicago, America) were evaluated. Disease types or health status were determined according to the pocket depth, the amount of clinical attachment level, and the bleeding rate on probing. According to 2018 (Papapanou et al., 2018) new periodontal classification, individuals were divided into three groups: periodontal health (31 individuals-control group), gingivitis (31 individuals-test group) and periodontitis (31 individuals-test groups).

2.3. Food Consumption Records

To determine the daily energy and nutrient intakes and the amount of consumption of food groups, food consumption records were kept by the nutritionist using the 24-hour recall method (Pekcan, 2008). Food consumption records were taken for three consecutive days, one of which was on the weekend. If communication with the patient was interrupted, one-day records were used to prevent data loss. A form, including the name of the dish, the foods inside, sizes, and the amount of all foods, was questioned for the records. Then, individuals' dietary energy and nutrient intakes were calculated using the Nutrition Information System program (BeBiS, 2011). This database contains Turkish food composition tables for all foods. Finally, the level of meeting individuals' daily dietary vitamin and mineral intake was evaluated using the recommendations of the Turkish Nutrition Guideline (TÜBER, 2015).

2.4. Fermented Food Consumption Frequency

Data on individuals' frequency and amount of consumption of some fermented products were recorded considering the foods available in our culture and the market. The foods questioned were evaluated using a 7-point Likert-type frequency form (every day, 1-2 per week, 3-4 per week, 1 per month, 2 per month, 1 per year, never). In addition, the amounts of foods consumed each time were recorded, and the daily consumption amounts were obtained by dividing them by the frequency of consumption.

2.5. Statistical Analyses

Study data were analyzed using the SPSS 23 package program. According to the results of the normality test for the data before the hypothesis tests, in the Kolmogorov-Smirnov test, the p-value was over 0.05, and it was concluded that the sample size was also suitable for the parametric test criteria. One-way analysis of variance (One-way ANOVA) and chi-square analysis were used to compare study groups according to data. The Bonferroni test was used as a post hoc test for the significant differences. The significance level was accepted as 0.05 in all analyses.

3. Results

General information about individuals is given in Table 1. Accordingly, all groups have a similar distribution regarding age, body weight, height, and gender (P>0.05). Data on the energy and macronutrient intakes of the participants are given in Table 2. Accordingly, the daily energy intakes of individuals with unhealthy and healthy periodontium are similar (P>0.05). Likewise, there was no significant difference regarding protein intake (g), protein intake per body weight, percentage of energy from protein (protein %), fat (g), carbohydrate (g) intakes, percentage of energy from carbohydrates (carbohydrate %) and fiber (g) among unhealthy and healthy periodontium groups (P>0.05). It was observed that the percentage of energy from fat (fat %) was the highest (43.20±8.53) in patients with gingivitis and the lowest (38.19±7.25) in patients with periodontitis (P=0.042). Regarding the distribution of energy from fatty acids, while there was no difference between the groups regarding mono and polyunsaturated fatty acids, it has been found that patients with periodontitis have a lower percentage of saturated fatty acids than patients with gingivitis and individuals with periodontal health (P=0.002). Patients with periodontitis also had the lowest percentage of energy from short and medium-chain fatty acids (P=0.003).

There was no difference between the groups regarding the participants' vitamin and mineral intake (Supplementary Table 1). In addition, the meeting value of vitamin and mineral intakes according to the recommendations of the nutritional guideline was similar between the groups (Supplementary Table 2).

Table 1. General information about individuals (n=93) ($\bar{x}$ ± SD)

Properties		Healthy gingiva	Gingivitis	Periodontitis	P
Age (year)*		34.13±13.21	38.10±13.65	39.97±11.23	0.183
Body weight (kg)*		67.28±14.11	75.37±16.47	72.87±11.50	0.074
Height (cm)*		167.16±5.62	169.60±10.05	166.23±9.90	0.302
Gender (%)**	Men	9 (28.1%)	13 (43.3%)	12 (38.7%)	0.441
	Women	23 (71.9%)	17 (56.7%)	19 (61.3%)	

*One-way Anova test, **Chi square test

Table 2. Energy and macronutrient intakes of individuals (n=93) ($\bar{x}$ ± SD)

Energy and nutrients	Periodontal Health	Gingivitis	Periodontitis	P
Energy (kcal)	1493.61±740.93	1394.49±481.85	1405.36±434.16	0.753
Protein (g)	57.34±27.72	52.94±21.76	52.37±13.15	0.613
Protein (g/kg)	0.87±0.40	0.72±0.27	0.73±0.22	0.107
Protein (%)	15.88±3.12	15.63±3.84	16.00±4.59	0.933
Fat (g)	68.07±40.45	67.86±28.71	59.23±18.16	0.435
Fat (%)	40.16±7.20^{a}	43.20±8.53^{b}	38.19±7.25^{c}	0.042*
Saturated fatty acids (%)	14.58±3.70^{a}	15.29±3.19^{a}	12.20±3.59^{b}	0.002*
Short and medium chain fatty acids (%)	1.88±0.72^{a}	1.99±0.72^{a}	1.38±0.74^{b}	0.003*
Monounsaturated fatty acids (%)	14.79±3.73	15.03±3.63	13.57±3.15	0.222
Polyunsaturated fatty acids (%)	7.93±2.88	9.79±5.27	9.50±2.79	0.119
Carbohydrate (g)	158.80±78.20	139.79±61.09	161.76±67.00	0.410
Carbohydrate (%)	43.72±8.75	41.20±10.92	45.77±10.27	0.208
Fiber (g)	15.33±8.97	16.30±7.31	17.04±6.94	0.685

^{a,b,c} Statistically significant values has marked with different letters (a), (b) or (c), P<0.05.

Consumption amounts of food groups of individuals are given in Table 3. Legume consumption in both patient groups (gingivitis and periodontitis) was higher than in individuals with periodontal health (P=0.004). Consumption of dairy products (except cheese) was higher in the periodontal health group than in the patient group (P=0.009). Cheese is consumed less than other groups in patients with periodontitis (P=0.025). The highest coffee consumption was in individuals with periodontal health and the lowest in periodontitis patients (P<0.036). Consumption of other food groups was similar (P>0.05).

Table 4 shows the intake of some fermented foods according to the frequency of consumption by individuals. Consumption of the whole-grain bread types and kefir was significantly different between the groups (P=0.010 and P=0.013, respectively). Consumption of whole-grain bread types was higher in individuals with periodontal health than in patient groups. Kefir is consumed by individuals with the highest periodontal health and the lowest by patients with periodontitis. There was no difference between the groups regarding the consumption frequency of fermented foods (Supplementary Table 3).

Table 3. Consumption amounts of food groups of individuals (n=93) ($\bar{x}$ ± SD)

Food groups	Periodontal health	Gingivitis	Periodontitis	P
White bread and bagels	68.31±66.33	67.63±55.10	89.87±58.37	0.261
Whole breads	20.41±30.99	13.93±41.25	10.23±30.70	0.498
Cereals and cereal products	57.06±40.35	44.87±37.60	61.52±34.92	0.210
Pastries and snacks	21.53±25.45	23.10±45.52	11.84±17.54	0.319
Eggs	42.28±50.63	27.30±25.35	30.29±23.31	0.218
Fruits	105.41±106.99	85.20±96.37	128.06±132.75	0.339
Vegetables	238.56±263.10	255.00±167.29	176.74±107.58	0.245
Nuts and seeds	15.00±15.63	26.83±33.34	18.61±15.48	0.121
Legumes	5.75±7.41[a]	13.90±13.17[b]	14.65±12.83[b]	0.004*
Potatoes	39.06±44.53	44.13±59.12	52.26±46.35	0.578
Dairy products (except cheese)	139.16±112.72[a]	91.20±80.52[b]	72.87±55.16[c]	0.009*
Cheeses	29.13±18.67[a]	37.67±27.69[b]	22.55±16.35[c]	0.025*
Non-alcoholic sweet drinks	44.22±87.56	37.77±69.30	28.90±51.90	0.695
Coffee	42.91±70.69[a]	30.67±45.95[b]	10.03±18.15[c]	0.036*
Tea	284.31±291.20	420.60±318.32	331.52±258.04	0.179
Soda	28.47±67.11	20.03±46.02	0.00±0.00	0.055
Alcoholic beverages	5.25±26.29	0.00±0.00	1.06±5.93	0.384
Oils	17.53±9.80	17.00±9.67	19.71±7.78	0.470
Fats	5.41±5.65	5.47±6.45	4.74±4.85	0.857
Sugary foods (total)	30.59±64.34	18.33±21.43	21.23±22.44	0.481
Sugar. honey. molasses. jam. etc	12.75±17.90	10.67±14.62	15.13±16.05	0.565
Ice cream and chocolate	17.84±51.60	7.67±13.18	6.10±16.99	0.306
Meats (total)	101.84±83.23	80.40±75.59	86.77±53.37	0.484
Fishes	5.41±21.29	1.10±6.02	6.97±27.73	0.518
Red meats	42.91±54.74	36.93±37.55	45.29±42.08	0.763
Poultry meats	47.31±57.24	36.23±64.14	32.26±49.42	0.558

[a,b,c] Statistically significant values has marked with different letters (a), (b) or (c), P<0.05.

Table 4. Intake amounts of some fermented foods according to the consumption frequency of individuals (n=93) (g/day) ($\bar{x}$ ± SD)

Fermented foods	Periodontal health	Gingivitis	Periodontitis	P
Yogurt	115.78±70.74	87.70±63.75	89.29±62.55	0.171
Probiotic yogurt	1.94±7.70	0.50±1.78	3.45±17.96	0.599
Boza	0.72±2.57	1.87±8.12	1.45±7.72	0.785
Tarhana	27.91±31.85	29.37±32.41	31.16±39.25	0.933
Sausage	5.16±6.01	6.47±10.12	5.87±8.72	0.828
Bacon	0.47±1.80	0.27±0.69	0.87±3.58	0.595
Soy Sauce	0.50±1.55	0.03±0.18	0.03±0.18	0.072
Pickle	6.91±9.99	5.10±8.58	10.06±20.92	0.392
Sourdough bread	5.69±16.05	8.53±32.46	11.42±29.28	0.697
Whole grain breads	34.15±40.65[a]	16.23±31.42[b]	9.41±22.40[b]	0.010*
Ayran	114.47±176.06	87.87±90.64	72.45±94.20	0.420
Kefir	42.25±74.78[a]	17.97±52.47[b]	2.00±9.73[c]	0.013*
Şalgam	3.63±17.74	1.33±6.12	4.68±12.87	0.604

[a,b,c] Statistically significant values has marked with different letters (a), (b) or (c), P<0.05.

4. Discussion

The frequency and amount of consumption of some fermented foods by individuals with periodontal disease and periodontal health and their nutrient intakes were evaluated and compared. Research data show that periodontal health can be achieved by substituting saturated fats with monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), specifically n-3 PUFA (Varela-López et al., 2015). There is much information that omega-3 fatty acids have a positive role due to their antibacterial, antioxidant, and immunomodulatory effects (Varela-López et al., 2016). High saturated fatty acid intake poses a risk for periodontitis (Watson et al., 2022). Along with that, a low-fat and high-fiber diet for eight weeks improved periodontitis markers (Kondo et al., 2014). In this study, saturated fat intake was lower in patients with periodontitis, contrary to the literature; however, the percentage of energy from saturated fatty acids is above the recommended values in all three groups. It is recommended to reduce saturated fatty acids in the diet as much as possible and to keep below 10% according to the recommendations of the Turkish Nutrition Guideline (TÜBER, 2015). On the other hand, intakes of short and medium-chain fatty acids, which are saturated fatty acids, were low in individuals with periodontitis. It has been reported that short and medium-chain fatty acids have an inhibitory effect on pathogenic microorganisms in the oral cavity (Huang et al., 2011). Therefore, it was thought that when the fat content of the diet is high, the type of fatty acids and total fat intake may affect periodontal health.

Increasing the intake of whole grains without increasing the total energy intake in the diet may reduce the risk of periodontitis (Merchant et al., 2006). An inverse association between a high-fiber diet and periodontal disease has been found among US adults aged 30 and older. This is related to low whole grain intake in patients with periodontal problems (Nielsen et al., 2016). Whole grain foods have a low glycemic load and high fiber, zinc, and vitamin E content. These components may be important in maintaining periodontal health (Kaur et al., 2016; O'Connor et al., 2020; Santonocito et al., 2021). It is also one of the main components of healthy dietary patterns associated with high whole grain consumption and low risk of periodontal disease (Altun et al., 2021). Whole grains have high polyphenol content, especially phenolic acids, flavonoids, and lignans (Tian et al., 2019). Polyphenols can reduce the initiation and progression of periodontitis by biological mechanisms with their anti-inflammatory and antioxidant effects (Basu et al., 2018). The selection of polyphenols at each meal or snack, combined with oral hygiene care measures, prevents periodontitis and other chronic inflammatory conditions that cause it (Palaska et al., 2013). To our knowledge, there is no study on the relationship of wholemeal bread, another type of bread, with periodontal diseases. However, it has been shown to have the best antioxidant potential due to buckwheat wholemeal flour's high free phenol content (Škrovánková et al., 2020). In this study, the consumption of whole-grain bread is higher in individuals with periodontal health.

Legumes are expected to positively affect oral health since they have slowly digestible starch content and high antioxidant vitamin and mineral content (Halvorsrud et al., 2019). To our knowledge, although there are no data on the relationship between legume consumption and periodontal diseases, a study evaluating seed/legume consumption concluded that these nutrients are not associated with severe periodontal disease (Salazar et al., 2018). In this study, legume consumption was lower in individuals with periodontal health than in individuals with periodontal disease.

Coffee has antioxidant and anti-inflammatory effects, as well as caffeine (Ng et al., 2014). An imbalance between oxidative stress and antioxidant capacity plays an essential role in the pathogenesis of periodontal disease (Guentsch et al., 2008). The primary etiologic basis of periodontal disease is a bacterial disease, and excessive host inflammatory response may be critical to the pathogenesis of periodontitis (Guentsch et al., 2008). There is an inverse correlation between drinking one cup or more of coffee per day during the maintenance phase of periodontal treatment and the occurrence of periodontitis (Hečimović et al., 2011). Coffee consumption was higher in patients with less bone loss. This suggests that coffee may have a protective effect on periodontal health (Duarte and Reis, 2015). In this study, it was observed that individuals with periodontal health drank higher amounts of coffee, and patients with periodontitis consumed less coffee than patients with gingivitis.

Consumption of milk and fermented products reduces the risk of periodontitis (Adegboye et al., 2012). Regular milk-based protein consumption can effectively reduce alveolar bone loss in periodontitis (Seto et al., 2007). It has been shown that milk proteins affect bone metabolism by promoting bone formation, suppressing bone resorption, and maintaining the balance of bone remodeling in healthy adult men (Toba et al., 2001). Milk and its products (e.g., yogurt, cheeses and kefir) are also the best sources of calcium (Hildebolt, 2005; Adegboye et al., 2012). Calcium and vitamin D intake prevents osteoporosis and ensures the attachment of the tooth to the alveolar bone (Krall et al., 2001). In periodontal disease, vitamin D and calcium deficiency result in bone loss and increased inflammation (Hildebolt, 2005). Eating a diet low in calcium may result in severe periodontal disease (Nishida et al., 2000). In this study, milk and cheese consumption was low in patients with periodontitis, which supports the literature. In addition, fermented foods reduce the risk of periodontitis through probiotic or antibacterial activities, depending on the density of lactic acid bacteria they contain (Farnworth, 2005; Şanlier et al., 2019). Kefir is an acidic and slightly alcoholic fermented milk believed to come from the

Caucasus mountains (Liu and Lin, 2000). It has antibacterial action against many pathogenic organisms due to forming organic acids (hydrogen peroxide, acetaldehyde, carbon dioxide) and bacteriocins (Helander et al., 1997). In animal studies, kefir has been shown to reduce bone loss and inflammation (Vieira et al., 2021). When the effects of kefir on cariogenic bacteria and the number of these bacteria, and the relationship of *Lactobacillus* with periodontopathogens are examined, it is predicted that it can be used in the treatment of periodontal diseases (Şahin and Özmeriç, 2021). In this study, the findings showed that individuals with periodontal health consume more kefir than patients with gingivitis and periodontitis.

The strength of the present study is that gingivitis and periodontitis, which are periodontal diseases, were separately evaluated regarding dietary intake. In addition, foods belonging to Turkish culture were questioned to determine the protective role of fermented food consumption habits in oral health. The small sample size and the inability to assess the causality of the data obtained due to the nature of the study were the limitations of the present study. On the other hand, the results cannot be generalized due to the differences in fermented food consumption between cultures.

In conclusion, based on the differences regarding dietary fatty acid content, consumption of dairy products, coffee, as well as whole-grain bread and kefir from fermented foods between study groups, the type of foods and nutrients may be associated with periodontal disease and healthy periodontium. However, these results should be validated in different cultures and larger samples.

Author Contributions

The percentage of the author contributions is presented below. The author reviewed and approved the final version of the manuscript.

	T.Ş.	Y.E.Ö.	N.Ö.
C	40	30	30
D	40	40	20
S	50	30	20
DCP	50	50	
DAI	50	50	
L	70	30	
W	70	30	
CR	30	30	40
SR	50	50	
PM	50		50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Approval/Informed Consent

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Gazi University Faculty of Dentistry Clinical Research Ethics Committee (approval date: June 18, 2020 and protocol code: GÜDHKAEK.2020.13/4) and registered at ClinicalTrials.gov (NCT05602545). Written informed consent was obtained from all subjects.

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