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Jacobs Journal of Dentistry and Research

Clinical Trial

The Effects of Plant Substances on the Extent and Clinical Course of Treatment-Resistant Chronic Periodontitis

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Received: 09-29-2015

Accepted: 10-23-2015

Published: 11-02-2015

Abstract

Aim

Investigation of the effect of dietary supplementation with plant substances on the course of refractory chronic periodontitis in various risk groups.

Materials and Methods

30 subjects with refractory periodontitis were given the plant extract JuicePLUS+® whilst otherwise continuing with unchanged oral hygiene and diet. The primary research parameters were plaque accretion (API), bleeding index (BOP) and probe depth. Secondary soft parameters were the effects of the dietary supplementation on oral and general well-being.

Results

We observed a 19.3% reduction in the BOP. In 90% of subjects the bleeding index improvement. 63% achieved a marked improvement in their inflammatory state within two months; no notable improved were seen later in the trial. The periodontal pocket depths reduced by on average 0.164mm (upper jaw) and 0.292mm (lower jaw). The soft endpoints improved markedly. No differences in the efficacy of the supplement between individual risk groups were seen. No side effects of the supplement were reported. 10 months after the study, 70% of the subjects reported a positive effect during the study.

Conclusion

Dietary supplementation with JuicePLUS+® can favorably influence the extent and clinical course of refractory periodontitis and can positively stimulate the psyche.

Clinical relevance

Scientific rationale for the study

Dietary supplementation can be beneficial in inflammatory conditions. In periodontitis, Chapple et al. found supplementation with JuicePLUS+® to reduce inflammation. We aimed to confirm their findings and extend them to patients whose periodontitis had relapsed on conventional treatment.

Principal findings

JuicePLUS+® intake reduced inflammation (average 19.3%

reduction in BOP) in 90% of patients. This occurred without improved oral hygiene. The effect was seen within 2 months of supplementation and continued, but did not increase, with time.

Practical implications

Dietary advice/supplementation should be considered early in the management of periodontitis.

Introduction

Chronic periodontitis is one of the commonest chronic inflammatory conditions. It represents a large clinical and health economic problem due to its wide distribution and consequences. After the age of 40, periodontitis is the main cause of tooth loss [1]. There are numerous causes and contributing factors. Age, gender, oral hygiene, general illnesses (diabetes, osteoporosis) and life circumstances (stress, smoking, nutrition) all influence the development and clinical course of the condition [2-5].

A long term and durable relief of symptoms and the avoidance of tooth loss are desirable goals.

Although the brief use of a specific antibiotic may seem sensible and is in some cases unavoidable, in the long term stabilization of the immune system is of prime importance [6]. A balanced diet is an effective option to boost the immune system [7,8]. Large epidemiological trials have established connections between anti-oxidant micronutrients and the extent of periodontitis [9,10].

It has been established that vitamin C [11,12], folic acid [13,14], vitamin D [15], as well as calcium [16], and magnesium [17,18] all play important roles in preserving periodontal health. Because of these complex interrelationships and its capacity to be influenced by diet, periodontitis may be viewed as a nutritional deficiency disease.

Dietary recommendations for patients with periodontitis such as those of Staudte [19, 20] and the development of targeted dietary concepts (e.g. Itis-Protect+® from the firm Hypo-A+®) show how important to oral health a balanced dietary intake is.

Chapple et al. investigated the effect of dietary supplementation with the plant concentrate JuicePLUS+® on the clinical course of chronic periodontitis [21]. Their results showed a marked regression of the periodontal inflammation and confirmed the positive, inflammation-limiting influence of an elevated intake of plant constituents.

The goal of the study was to test whether dietary supplementation with a plant concentrate over 4 months in a group of patients with refractory periodontitis can produce an improvement in the periodontal situation and what implications might arise from a successful outcome for the treatment of chronic periodontitis. In addition, the question arose as to whether we could confirm the results of the study by Chapple et al.

Material and Methods

Study design and subjects

30 subjects with the following criteria were enrolled: adult patient (> 18 years old), treated chronic periodontitis [22] with relapse after 3-12 months, regular participation in review, no history of use of dietary supplements, no allergies to the constituents of JuicePLUS+®. Prior to the start of the study, all subjects had undergone the standardized treatment protocols of conventional medical management of periodontitis. After pre-treatment and hygiene phases, this took the form of full mouth disinfection [23,24]. This was followed by maintenance therapy. If after 3-12 months there was a relapse, the patient fulfilled the inclusion criteria and if, after explanation, they gave signed consent to participate in the study, then they were enrolled into the trial. An overview of all included subjects is presented in Table 1.

Table 1. Overview of patients.

Pat. No.	Ages	assessment	gender	smoker	medication	crowns	missing teeth	implants	bacteria
01	44	-	f	former	-	4	3	1	+/7
02	37	mother	m	-	Omeprazole	1	0	0	+/2
03	44	mother	m	-	-	3	0	0	+/1
04	31	-	f	-	-	0	0	0	-
05	41	mother	m	-	-	0	2	0	-
06	30	-	m	+	-	0	0	0	-
07	30	-	m	-	asthma	0	1	0	-
08	63	-	m	+	Ramipril	18	2	0	+/2
09	63	-	f	+	-	15	8	0	+/2
10	42	mother	m	-	-	2	1	0	-
11	59	-	f	-	Ramipril	10	2	0	-
12	51	-	f	+	-	0	0	0	-
13	54	-	m	-	-	7	8	0	-
14	41	father	m	-	-	1	0	0	+/2
15	38	mother	f	-	-	2	1	0	+/7
16	48	-	m	-	-	8	6	2	-
17	40	-	m	+	-	0	1	0	+/7
18	70	mother	f	+	beta-blocker	11	1	0	-
19	43	-	f	+	-	9	0	0	-
20	27	-	m	+	immunosupp	6	0	0	+/7
21	65	father	f	-	-	4	6	0	+/7
22	39	father	m	+	-	0	9	0	-
23	58	-	m	+	-	0	8	0	-
24	53	-	m	-	-	10	2	0	-
25	50	mother	f	-	-	3	4	0	-
24	48	-	f	+	-	3	6	0	-
27	38	-	f	-	hepatitis B	0	0	0	-
28	37	mother	f	-	-	0	2	0	+/7
29	65	-	m	+	-	0	8	0	-
30	59	father	f	+	-	1	6	0	-

The subjects consisted of 16 males and 14 females. Their ages ranged from 27 to 70 years (mean 46.9 years). 14 subjects were smokers, 12 subjects had a familial predisposition to chronic periodontitis, 11 subjects had a proven congenital burden of periodontal pathology . In addition to dental assessment of the periodontal disease state, the following features were specifically examined in order to assess possible inter-dependencies: missing teeth, crowns, fillings, teeth replaced by implants or removable dentures.

Given the already existing study of Chapple et al [21] and its unambiguous evidence of the therapeutic effects of JuicePLUS+®, we decided against a placebo group for ethical reasons.

Nutritional adjustments/plant concentrate

In order to achieve a standardized dietary adjustment, and due to the already extant study of Chapple et al. [21] the plant concentrate JuicePLUS+® from the firm "The JuicePLUS Company Europe Ltd." was selected. JuicePLUS+® is a powder made from dried pulverized juices and mashes of a total of 27 different berries, fruits and vegetables. The preparation is entirely natural. The constituents are listed in the publication by Dr. Bradac [25]. JuicePLUS+® contains those constituents of the fruit, which can be extracted by juicing and mixing such as vitamins, minerals, trace elements and secondary plant substances. Investigations to date have demonstrated numerous positive effects on the organism [26-29].

The plant concentrate JuicePLUS+® was taken by the subjects in accordance with the manufacturer's recommendations (2 capsules daily of the fruit-, vegetable-, berry-mixture).

Procedure, hard and soft end-points

The subjects were divided into groups based on gender, smoking status, congenital periodontal burden and genetic predisposition.

The indices relevant to periodontitis were taken as hard endpoints, these being: plaque accretion (API in %)[30], bleeding (BOP in %) [31] and periodontal pocket depth (in mm). The measurements were each taken at the start (of dietary supplementation), after 2 months and after 4 months (end of observation period) and entered into tables.

The soft end-points were the developments in the psychological state and the well-being with respect to oral health. These were assessed at the start and end of the study using questionnaires developed for the purpose. For reproducibility and comparability, a 0-4 scale was introduced and the average value per patient and per measurement was calculated.

After the end of the study, the subjects were re-questioned on their experiences.

Results

Plaque index (API)

The patients exhibited a high average API of 52.7% at the start of the study. Oral hygiene had only improved by 3.7% at the close of the study. 10 subjects exhibited worse oral hygiene after the study than at the outset. Only 3 subjects achieved an API <35% by the end of the study (API <25% is desirable). The measurement of the plaque accretion was a snapshot. As such, the negligible average improvement cannot be evaluated. The average improvement of the API is shown in Figure 1.

Bleeding index (BOP)

The initial BOP was on average 65.2%. After 2 months, there was an average improvement of 27.0% (absolute 17.6%) to an average value of 47.6%. After the close of the study, the average BOP was 44.6%, corresponding to a 31.6% improvement (absolute 20.6%). Within the four-month observation period a 19.3% reduction could thus be attained. 73% of subjects already had improved BOPs after 2 months. After 4 months, 90% of the subjects experienced a reduction in the BOP. The BOP is closely linked to oral hygiene and thereby to the API. 10 subjects with improved BOP also had an improved API. 11 subjects achieved a reduction in inflammation (lower BOP) while the API remained unchanged or worsened. The average improvement in the bleeding index is shown in Figure 2.

Probe depth

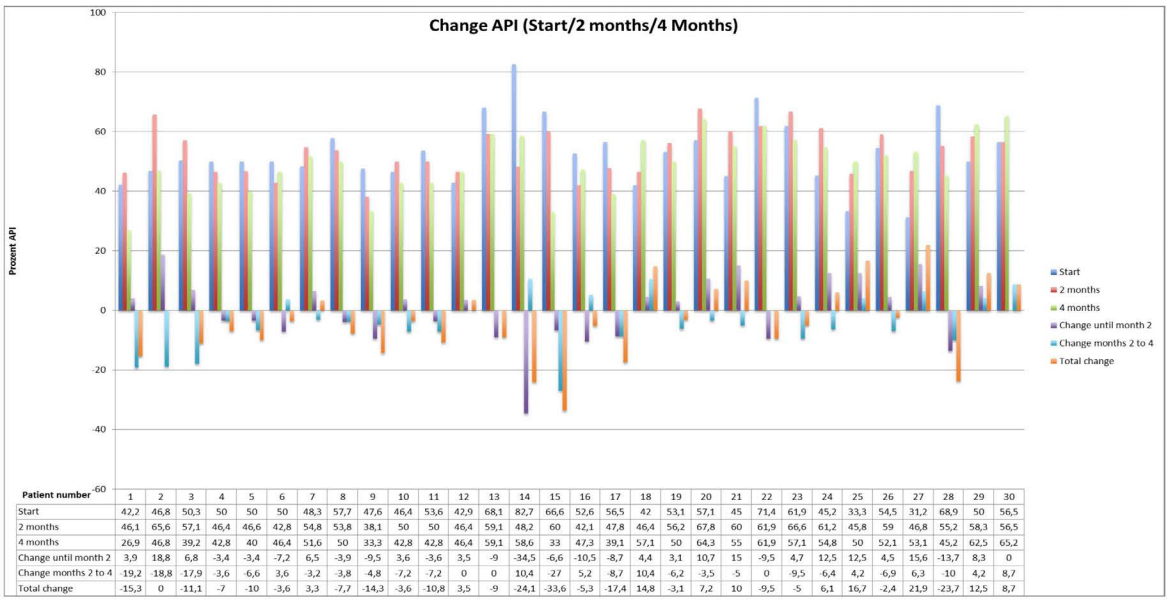
A slight reduction in the periodontal pockets was observed in both the upper and lower jaws. The improvement, averaging 0.164 mm in the upper jaw and 0.292 mm in the lower jaw, is slight but measurable and showed a positive trend. In 76% (upper jaw) and 80% (lower jaw) there were improved findings after 4 months. 7 subjects were unable to achieve any reduction in the periodontal pockets by the end of the study (5 of them smokers, 2 with genetic predispositions, 3 subjects with no particular distinguishing features). The average change in pocket depth is shown separately for the upper- and lower jaw in figures 3 and 4.

Soft end-points

15 subjects perceived improved well-being whilst taking the dietary supplement with the plant concentrate. 14 patients did not perceive any change and only one subject perceived a worsening. 13 subjects who did not improve already had a low value (< 0.3) at the start of the study and thereby a positive sense of well-being.

Questioning about satisfaction with oral health showed that, .

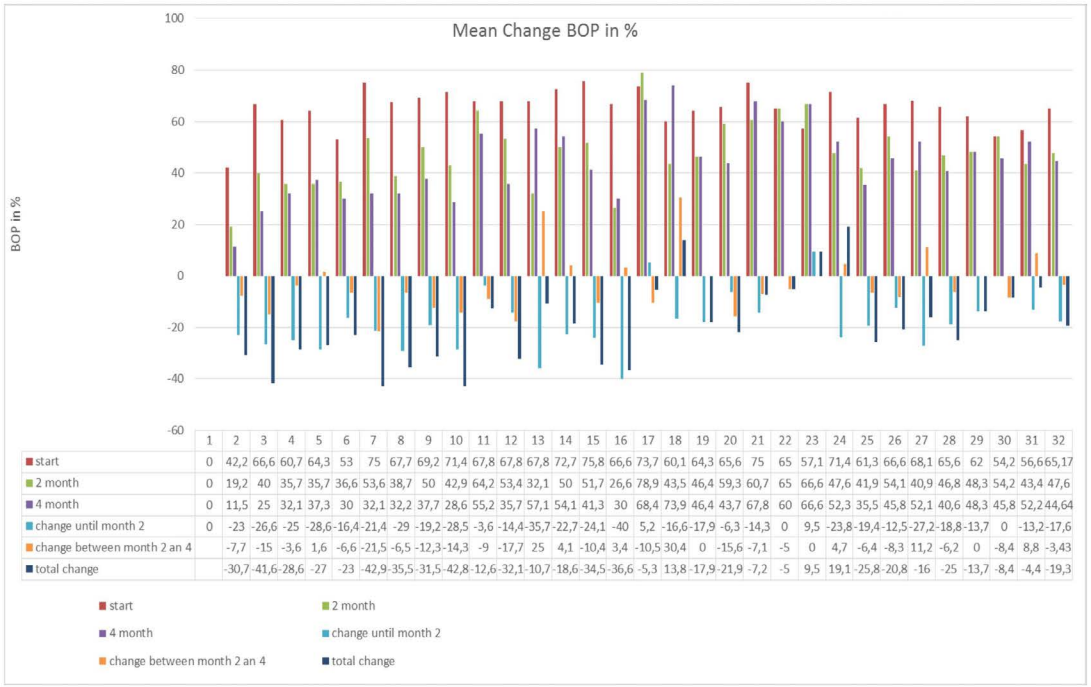
Figure 1. Mean change API in %.



Patient number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Start	42,2	46,8	50,3	50	50	50	48,3	57,7	47,6	46,4	53,6	42,9	68,1	82,7	66,6	52,6	56,5	42	53,1	57,1	45	71,4	61,9	45,2	33,3	54,5	31,2	68,9	50	56,5
2 months	46,1	65,6	57,1	46,4	46,6	42,8	54,8	53,8	38,1	50	50	46,4	59,1	48,2	60	42,1	47,8	46,4	56,2	67,8	60	61,9	66,6	61,2	45,8	59	46,8	55,2	58,3	56,5
4 months	26,9	46,8	39,2	42,8	40	46,4	51,6	50	33,3	42,8	42,8	46,4	59,1	58,6	33	47,3	39,1	57,1	50	64,3	55	61,9	57,1	54,8	50	52,1	53,1	45,2	62,5	65,2
Change until month 2	3,9	18,8	6,8	-3,4	-3,4	-7,2	6,5	-3,9	-9,5	3,6	-3,6	3,5	-9	-34,5	-6,6	-10,5	-8,7	4,4	3,1	10,7	15	-9,5	4,7	12,5	12,5	4,5	15,6	-13,7	8,3	0
Change months 2 to 4	-19,2	-18,8	-17,9	-3,6	-6,6	3,6	-3,2	-3,8	-4,8	-7,2	-7,2	0	0	10,4	-27	5,2	-8,7	10,4	-6,2	-3,5	-5	0	-9,5	-6,4	4,2	-6,9	6,3	-10	4,2	8,7
Total change	-15,3	0	-11,1	-7	-10	-3,6	3,3	-7,7	-14,3	-3,6	-10,8	3,5	-9	-24,1	-33,6	-5,3	-17,4	14,8	-3,1	7,2	10	-9,5	-5	6,1	16,7	-2,4	21,9	-23,7	12,5	8,7

Figure 1: reflects the course of the plaque index (oral hygiene status) in patients during the study. The values are reported in percentages. Negative values correspond to improvement (reduction in plaque accretion) and positive values to worsening (increase in plaque accretion). The calculated values were obtained using the procedure described in Material and Methods. The values were raised at "start," after "2 months," and at "study end." In addition, the percentage change is shown from "start until 2 months," from "2 months until study end," and "total change from start until end after 4 months."

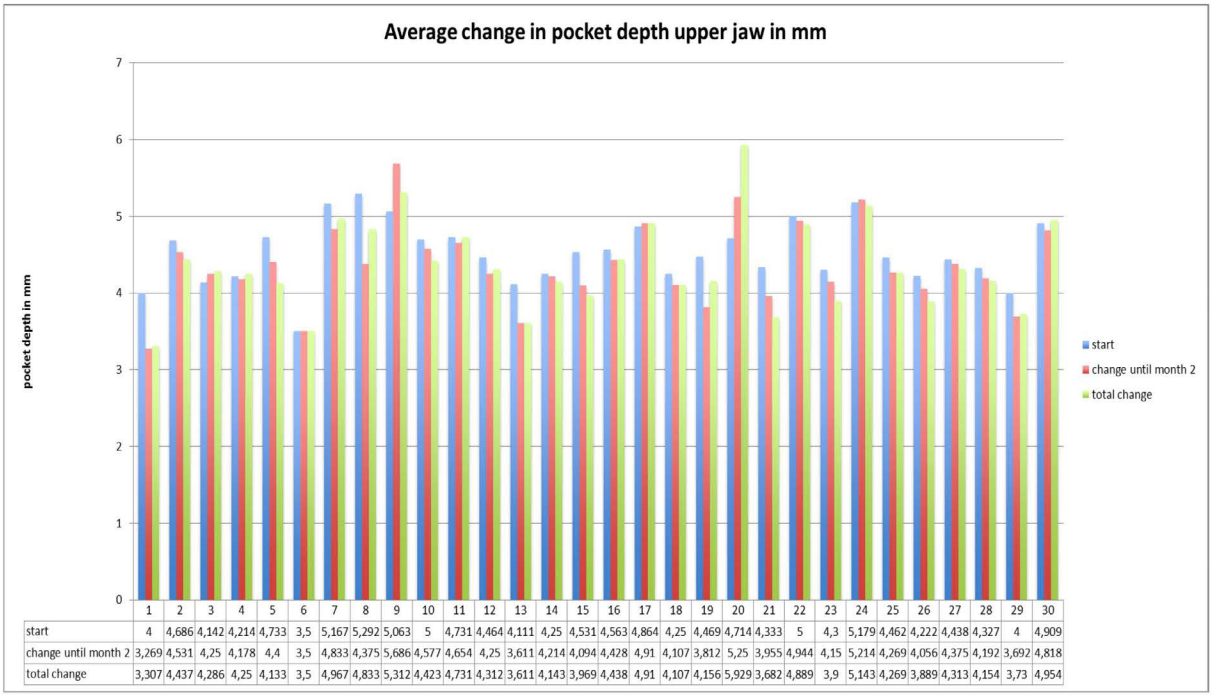
Figure 2. Mean change BOP in %.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
start	0	42,2	66,6	60,7	64,3	53	75	67,7	69,2	71,4	67,8	67,8	67,8	72,7	75,8	66,6	73,7	60,1	64,3	65,6	75	65	57,1	71,4	61,3	66,6	68,1	65,6	62	54,2	56,6	65,17
2 month	0	19,2	40	35,7	35,7	36,6	53,6	38,7	50	42,9	64,2	53,4	32,1	50	51,7	26,6	78,9	43,5	46,4	59,3	60,7	65	66,6	47,6	41,9	54,1	40,9	46,8	48,3	54,2	43,4	47,6
4 month	0	11,5	25	32,1	37,3	30	32,1	32,2	37,7	28,6	55,2	35,7	57,1	54,1	41,3	30	68,4	73,9	46,4	43,7	67,8	60	66,6	52,3	35,5	45,8	52,1	40,6	48,3	45,8	52,2	44,64
change until month 2	0	-23	-26,6	-25	-28,6	-16,4	-21,4	-29	-19,2	-28,5	-3,6	-14,4	-35,7	-22,7	-24,1	-40	5,2	-16,6	-17,9	-6,3	-14,3	0	9,5	-23,8	-19,4	-12,5	-27,2	-18,8	-13,7	0	-13,2	-17,6
change between month 2 an 4		-7,7	-15	-3,6	1,6	-6,6	-21,5	-6,5	-12,3	-14,3	-9	-17,7	25	4,1	-10,4	3,4	-10,5	30,4	0	-15,6	-7,1	-5	0	4,7	-6,4	-8,3	11,2	-6,2	0	-8,4	8,8	-3,43
total change		-30,7	-41,6	-28,6	-27	-23	-42,9	-35,5	-31,5	-42,8	-12,6	-32,1	-10,7	-18,6	-34,5	-36,6	-5,3	13,8	-17,9	-21,9	-7,2	-5	9,5	19,1	-25,8	-20,8	-16	-25	-13,7	-8,4	-4,4	-19,3

Figure 2: reflects the course of the bleeding index (inflammation marker) in patients over the course of the study. The values are reported in percentages. Negative values correspond to an improvement (reduction in bleeding/inflammation) and positive values to worsening (increase in bleeding/inflammation). The values were raised at "start," after "2 months," and at "study end." In addition, the percentage change is shown from "start until 2 months," from "2 months until study end," and "total change from start until end after 4 months."

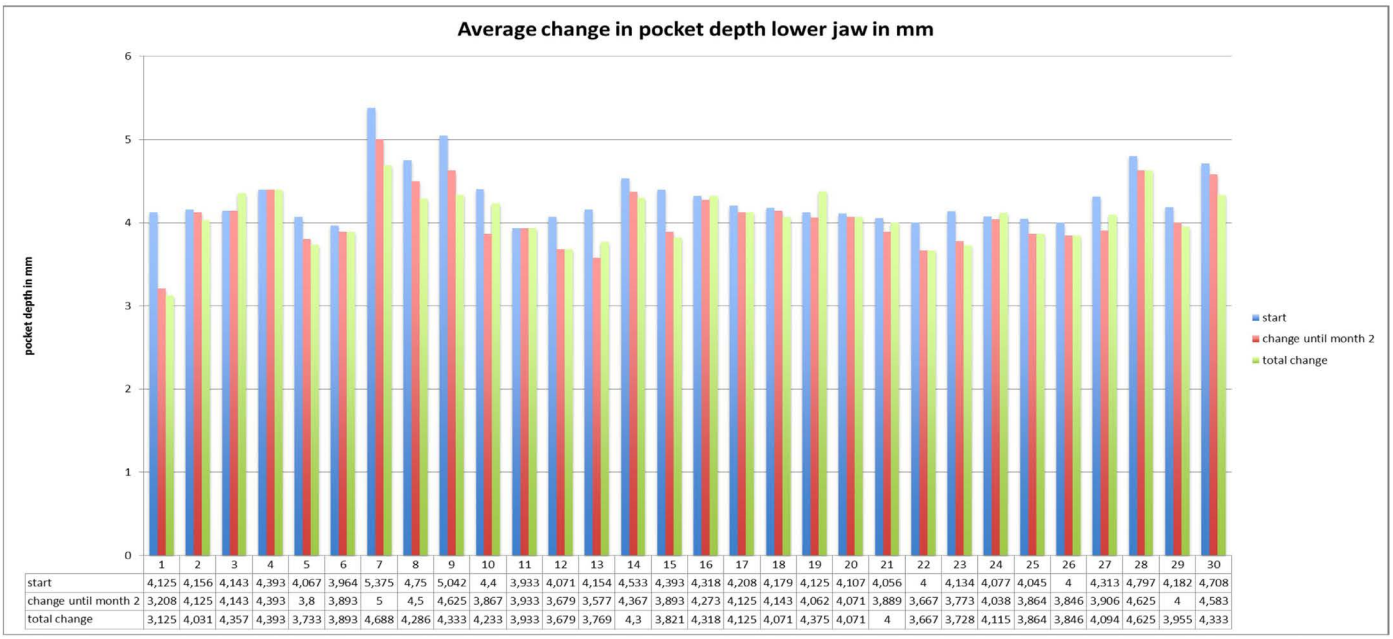
Figure 3. Mean change pocket depth in upper jaw in mm.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
start	4	4,686	4,142	4,214	4,733	3,5	5,167	5,292	5,063	5	4,731	4,464	4,111	4,25	4,531	4,563	4,864	4,25	4,469	4,714	4,333	5	4,3	5,179	4,462	4,222	4,438	4,327	4	4,909
change until month 2	3,269	4,531	4,25	4,178	4,4	3,5	4,833	4,375	5,686	4,577	4,654	4,25	3,611	4,214	4,094	4,428	4,91	4,107	3,812	5,25	3,955	4,944	4,15	5,214	4,269	4,056	4,375	4,192	3,692	4,818
total change	3,307	4,437	4,286	4,25	4,133	3,5	4,967	4,833	5,312	4,423	4,731	4,312	3,611	4,143	3,969	4,438	4,91	4,107	4,156	5,929	3,682	4,889	3,9	5,143	4,269	3,889	4,313	4,154	3,73	4,954

Figure 3: Reflects the change in pocket depth over the course of the four-month observation period. The values were grouped according to upper- and lower jaw. This was performed in order to determine potential differences of effects in the presence of different bone qualities (soft upper jawbone, hard lower jawbone). The values are reported in millimeters; the smaller the values, the smaller and healthier the pocket. The values were raised at "start," after "2 months," and at "study end."

Figure 4. Mean change pocket depth in lower jaw in mm**.**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
start	4,125	4,156	4,143	4,393	4,067	3,964	5,375	4,75	5,042	4,4	3,933	4,071	4,154	4,533	4,393	4,318	4,208	4,179	4,125	4,107	4,056	4	4,134	4,077	4,045	4	4,313	4,797	4,182	4,708
change until month 2	3,208	4,125	4,143	4,393	3,8	3,893	5	4,5	4,625	3,867	3,933	3,679	3,577	4,367	3,893	4,273	4,125	4,143	4,062	4,071	3,889	3,667	3,773	4,038	3,864	3,846	3,906	4,625	4	4,583
total change	3,125	4,031	4,357	4,393	3,733	3,893	4,688	4,286	4,333	4,233	3,933	3,679	3,769	4,3	3,821	4,318	4,125	4,071	4,375	4,071	4	3,667	3,728	4,115	3,864	3,846	4,094	4,625	3,955	4,333

Figure 4: Reflects the change in pocket depth over the course of the four-month observation period. The values were grouped according to upper- and lower jaw. This was performed in order to determine potential differences of effects in the presence of different bone qualities (soft upper jawbone, hard lower jawbone). The values are reported in millimeters; the smaller the values, the smaller and healthier the pocket. The values were raised at "start," after "2 months," and at "study end."

with the exception of 4 patients in whom no change could be established, all patients perceived improved oral hygiene while taking the diet supplemented with the plant concentrate. Worsening was not reported by any of the subjects questioned.

The 4 patients who did not perceive any improvement in their oral hygiene also did not perceive any improvement in their general well-being.

Results in patients with multiple relapses

In smokers and patients with a congenital periodontal disease burden, the risk of relapse of periodontal disease is increased. Therefore, these subgroups were separately studied further.
Smokers:

- 12 of the 14 smokers showed marked reduction in the BOP (≈85%)

- 8 of them experienced the greatest improvement within the first assessment

- interval (≈57%)

- probe depths in the upper jaw improved in 10 of 14 subjects (≈71%)

- probe depths in the lower jaw improved in 12 of 14 subjects (≈86%)

Patients with a congenital periodontal disease burden:

- in 10 of 11 subjects, marked reduction (≈91%)

- probe depths in the upper jaw improved in 8 of 11 subjects (≈73%)

- probe depths in the lower jaw improved in 10 of 11 subjects (≈91%)

A marked improvement in the inflammatory status could also be achieved in these two groups by means of the supplemented diet. Accordingly, no difference could be determined in the efficacy of immune system boosting between the individual groups.

Questioning after the end of the study

After the end of the study, the subjects were re-questioned: 25 subjects would happily continue to take the preparation because of its additional benefits. For 18, however, it was too expensive (290 €/4 months), for 4 it was too laborious to take it, 3 could not see any additional benefit. 5 subjects continued to take it after the end of the study.

10 months after the start of the study, the subjects were contacted again by telephone. Professional considerations meant that one follow-up could not be completed since the subject had changed practice. 27 subjects could be contacted. 8 subjects noted worsening of their periodontal and psychological status after stopping the treatment. 7 subjects (26%) continued to take the plant concentrate of their own accord up to that time. The lack of preparedness on the part of the subjects to continue taking the preparation, despite a notable improvement, can in this case be attributed to a poor economic situation. 19 subjects (70%) could identify an additional benefit and 12 of these 19 subjects would happily have continued taking the preparation but could not afford to do so. 7 of the 27, subjects reached (35%) noticed a renewed worsening of their periodontal status after stopping. 5 of the subjects could not identify any additional benefit despite objective improvement. Nearly all subjects who had objective improvement indicated during the telephone interview that they had felt an additional benefit from the plant concentrate but were not prepared, or in a position, to bear the large financial expense. If costs by the health insurances were to be assumed, a large number of patients would like to continue using the preparation.

The results described here are only valid for JuicePLUS+ ® and not transferrable to other preparations.

These results indicate that patient nutrition should be given significantly more importance in the management of chronic inflammatory conditions than has hitherto been recognized. The results are of considerable importance for research into, and management of, treatment-resistant periodontitis. Both for this condition, and potentially for other illnesses linked to inflammation, this therapeutic option offers additional opportunities.

Discussion

API

The degree of inflammation is closely linked to plaque accretion. The API is a snapshot and varies from day to day. Nearly all subjects showed a comparatively high plaque index. The average API at the end of the study was 49.1%. An API of < 25% is considered desirable. None of the subjects achieved this value. The dietary adjustment therefore had nearly no influence upon plaque accretion and the state of hygiene of the patients. This allows us to rule out an improvement in the BOP due to reduced plaque values.

BOP

The BOP improved markedly and quickly after starting the supplemented diet. The effect could already be demonstrated at the time of the first assessment after 2 months. Since the corresponding API only improved by an average of 3.7% during

this time period, and furthermore nearly all subjects had a high API of > 45%, the modest reduction in plaque accretion is insufficient to explain the marked reduction in inflammation. The significantly improved inflammatory status is thus highly likely to be attributable to the dietary supplementation. This is also suggested by the fact that 11 subjects showed improvements in BOP while the API either remained constant or worsened. A possible explanation could be an effect of the dietary supplement on blood coagulation.

To date, there are no studies on this interrelationship. With the knowledge of the change in BOP it would, however, be interesting to study the coagulation values under JuicePLUS+® administration.

Periodontal pocket depths

Both in the upper and lower jaw, the most marked reduction in the probe depth was achieved in the first study interval. This finding reflects the time course of the improvement in the inflammatory index (BOP). The reduction in inflammation is associated with a reduction in gum swelling and thereby a diminution of the probe depth (measured from the edge of the gum to the floor of the periodontal pocket). The most obvious explanation for the reduction in probe depth is a reduction in gingival swelling. Additional research methods would be required to demonstrate the formation of new edge epithelium. The reduction was small on average over the whole of the upper or lower jaw, but with a positive trend.

Well-being

The intake of the plant concentrate was associated with an increased feeling of well-being. The subjects felt better, more healthy and more secure in terms of their oral health. They reported that they had more energy and felt more resilient and balanced. The mood-improving and energizing effect was marked. Comparable mood-improving effects have also been described in other studies with a balanced diet and exercise [32,33] . It is conceivable that the intake of the plant concentrate JuicePLUS+® supplies the body with substances which in some people are not present in sufficient quantity but which are needed e.g. by the neurotransmitter system for the synthesis of dopamine.

Special subject groups

A comparison between the different risk groups did not reveal any differences in the efficacy of the dietary supplementation, either with respect to gender or in those subjects in whom there was a suspicion of reduced responsiveness to dietary intake (smokers) or evidence of a weakened immune system (congenital periodontal disease burden, genetic predisposition).

Possible explanation of the results

The effects are very likely to be attributable to the action of the plant concentrate since there were no other changes. Since the oral hygiene did not improve decisively during the study, a reduction in the amount of plaque could be ruled out as the cause of the reduced inflammation.

There are to date 29 published studies on the effects of JuicePLUS+®: the studies relating predominantly to the immune system, oxidative stress and bioavailability are relevant to the present study. Some authors attribute the efficacy of JuicePLUS+® to a pronounced anti-oxidant and anti-inflammatory action [34-36]. Jin et al. were able to show a significant reduction in various important markers of inflammation in the blood of healthy adults after only two months taking JuicePLUS+® [34]. Since periodontitis is a chronic inflammation, this action of the plant concentrate would be a possible route to explaining the improvement in the periodontal situation. Chronic periodontitis could thus be regarded as a dietary insufficiency disorder. If individual factors such as smoking, poor nutritional status, general illnesses and predispositions are also present and act as triggers of increased oxidative stress, which itself is linked with periodontal health, then the plant concentrate with its anti-oxidant properties could act to minimize this problem. Bamonti et al. were able to show that JuicePLUS+® also markedly reduced the anti-oxidant stress in smokers [37]. The following hypothesis for the action of the plant concentrate can therefore be formulated: replenishment of metabolic deficiencies, thereby support of the immune system and reduction of oxidative stress.

Since the individual constituents of the plants have not yet been fully identified, the exact composition of JuicePLUS+® is not known. The intake of capsules can neither substitute for a well-balanced diet nor for a healthy lifestyle. An experimental analytic investigation of the exact mode of action or the biochemical metabolism would be desirable to identify the exact bodily processes affected by intake of JuicePLUS+®.

The increased sense of well-being can also be explained by the more favorable provision of nutrients. Kawashima et al. and Samman et al. were able to demonstrate a marked reduction in the homocysteine level [38,39]. Elevated amounts of this amino acid in the blood are closely associated with the development of depression. Depression and low mood can frequently be attributed to a deficiency of chemical transmitters (neurotransmitters). Nutrients such as essential fatty acids, magnesium or vitamins B6, B9 and B12 play a decisive role in the production of neurotransmitters. Deficient body stores of these nutrients contribute to psychological imbalances, which can accelerate the development of depression and worsen a pre-existing depressive temperament [33,40,41]. The plant concentrate JuicePLUS+® may conceivably counteract this

mood-influencing nutritional deficiency.

Consequences for the treatment of chronic periodontitis

The study of Chapple et al has already been able to demonstrate a positive effect of dietary supplementation with the plant concentrate in chronic periodontitis [21]. The data from the present study show that JuicePLUS+® can also produce improvements in the objective and subjective complaints in patients with relapsed periodontitis in whom the conventional therapeutic options had not produced any improvement.

It follows from this that a dietary history should be obtained from, and dietary advice given to, patients with chronic periodontopathy from the very beginning of their management.

Compared to conventional methods of supportive therapy for periodontitis (laser, photodynamic therapy, local / systemic antibiosis, antiseptics), dietary supplementation offers an additional option. There are no irreversible side effects or application errors. Local therapy with antibiotics or a highly concentrated antiseptic can only be used in a targeted fashion on individual periodontal pockets. The systemic delivery of nutrients, by contrast, both replenishes metabolic deficiencies and supports the immune system. In addition, it can be adopted as a lifelong supportive measure and has further positive accompanying effects on the organism [27] .

Should dietary adjustment or supplementation prevail as a therapeutic option in chronic periodontopathy, this would be an enormous advance. This is also true from an economic viewpoint. Although dietary supplementation with JuicePLUS+® means an initial higher expense for the patient (€ 290/4 months), a successful and prolonged reduction of periodontal inflammation would be able to prevent extensive treatment with high follow-on costs (antibiotic prescriptions, surgical periodontal treatment, tooth extractions and the resulting prosthetic replacement of the tooth gaps.) The difference is that patients must cover the costs for the dietary supplementation themselves, while the costs associated with follow-on treatment are usually assumed by statutory or private health insurances. Therefore, patients' motivation to cover the high cost of therapies themselves, such as with JuicePLUS+®, is understandably low. If long term studies are able to demonstrate lasting treatment success with the dietary supplement, the health insurances should consider to at least partially assume the costs. This would allow the economic aspect of JuicePLUS+ to become obvious, and the health insurances could save the high costs associated with the consequences and complications of chronic periodontitis in the long term. Diseases secondary to the periodontitis such as cardiological problems [42,43] and difficult-to-control diabetes [44,45] could also be favorably influenced. Since the JuicePLUS+® product only consists of natural ingredients according to the manufacturer, a plant-based diet with comparable constituents ought in principle to produce an improvement in the periodontal status. If the patient is not in a position to adjust their diet in the recommended manner [19], then the plant concentrate JuicePLUS+® represents an alternative.

A possible risk of the dietary supplementation , particularly in especially health-conscious patients, is the danger of overdose [46]. Particularly in smokers and patients with liver damage, there is an increased risk of developing lung or liver cancer as a consequence of high doses of vitamin A [47,48]. Since smokers are particularly prone to relapsing periodontitis, this danger should be mentioned and explained.

It should be stressed that conventional dental therapy is indispensible - thorough supra- and sub-gingival cleaning by the therapy team and patient is the basis of any success. Pulsed antibiotic therapy is also sensible with certain indications and should not be omitted. Similarly, the elimination of confounding factors and dental assessments should take place. Additional requirements for lasting treatment success include lifestyle adjustment by the patient, such as giving up tobacco consumption and good compliance. These measures can be supported by dietary supplementation with JuicePLUS+®.

Comparison with the Chapple et al study

As the currently only available publication, the study by Chapple et al [21] examined the effect of JuicePLUS+® in periodontitis patients. In this study, 60 subjects with diagnosed periodontitis were treated either with the JuicePLUS+® fruit-, berries- and vegetable selection, with the JuicePLUS+®fruit- and vegetable selection, or with the placebo. After three months of JuicePLUS+® administration, positive results were seen both in terms of the periodontal pocket depth measurement, as well as in an increase of the connective tissue, in bleeding on probing (BOP), and plaque formation. After 9 months, in all study groups a reduction in the recession, plaque formation, bleeding rate and reddening of gums could be achieved. From the second month, a reduction in the pocket depth could also be documented.There was a significant difference between Juice Plus and Placebo.

However, Chapple et al examined subjects with a first diagnosis of periodontitis. Smokers were excluded and a significantly higher number of women than men were examined [21,25]. Despite these differences in the selection of the patient collective and the study design, the results of the present study are consistent with the study by Chapple et al. JuicePLUS+® appears to have beneficial effects both for refractory- as well as first-appearing periodontitis.

Acknowledgements

This research is based on the thesis of Fee Wiesinger "Einfluss pflanzlicher Substanzen auf den Verlauf der therapieresistenten chronischen Parodontitis " at the Medical Faculty of the Ludwig-Maximilians University of Munich (submitted).

Conflict of interest and Sources of funding

No external funding, apart from the authors' institution, was available for this study

The authors declare that there are no conflicts of interest in this study.

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