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Original article

Effects of bee pollen on athletes' conditions and exercise performances.

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Abstract

Bee pollen is a pellet of pollen made by honeybees. We investigated the effects of continued consumption of bee pollen on athletes' conditions and exercise performance. Bee pollen or placebo was consumed continuously for 16 weeks, during which time, body composition measurements, stress checks, GO/NO GO tests, glycation stress measurements, stress, motivation, arthralgia, etc. were subjected to paper-based Visual Analogue Scale (VAS). They also received training data (bench, squat, clean, deadlift and 1000 m running) provided by the study subjects during the same period. In addition, the questionnaire was carried out using the mail function of the mobile phone once a week. The results showed that physical stress and muscle mass were significantly improved in the Bee Pollen group compared with the placebo group ($p < 0.05$). In addition, there was a tendency to alleviate mental stress in the Bee Pollen group. It was suggested that bee pollen intake may have a positive effect on athletic performance. However, there was eventually a marked reduction in the number of individuals included in the data analysis. Therefore, it is necessary to test again after taking measures to prevent the reduction of the target population.

***KEY WORDS*:** bee pollen; athletes; physical stress; muscle mass; mental stress

Introduction

Bee pollen is made by a bee and consists of pollens and honey in a cone form, which is placed on a legged "pollen cage" and taken home to the nest as a source of nutrients. Bee pollen is also used as a raw material for royal jelly and is considered to be an excellent source of nutrients because it contains nutrients for bees to live.

It has been consumed as a food since ancient times in Europe and the United States, and it is often eaten with sweets, salads, juices, etc., and it is considered to be a safe food that has been consumed routinely. It has been marketed in Japan since the 1980s, and its safety has been confirmed. In addition, it ranked sixth in the forecast of top 10 for super food trends in 2017, and has received attention in recent years. However, the functionality of bee pollen, a food, has not yet been evaluated.

Indeed, a variety of efficacy have been reported for pollens and honey bees, and bee pollen contains high-quality proteins, nucleic acids to prevent aging, minerals required for metabolism, enzymes to remove reactive oxygen species that cause aging and disease, and a variety of other nutrients, including various amino acids and vitamins. The compositions and contents of the components of Bee Pollen® (Api Co., Ltd., Gifu, Japan) are shown below (***Fig. 1, Table 1***) [1)].

Currently, foods rich in amino acids are marketed to athletes in Japan. Amino acids in this food include branched-chain amino acids (BCAA) such as valine, leucine,

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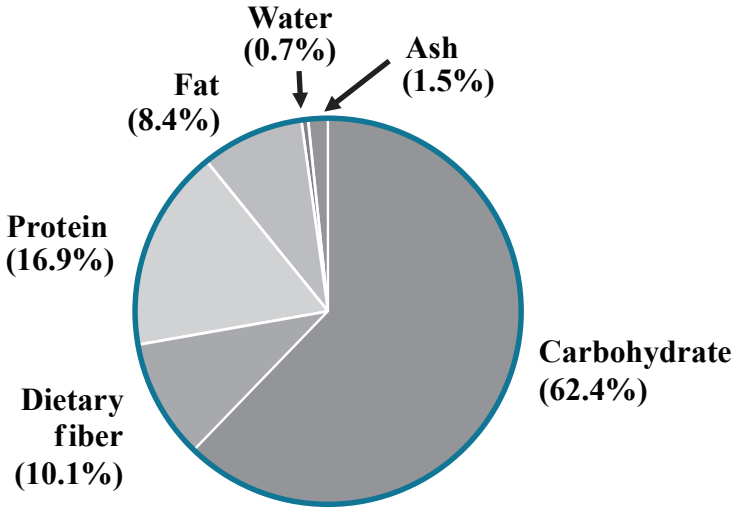

Fig. 1. **Bee pollen nutrient composition.**
Data are provided from Reference 1).

Table 1. Characteristic of 1 API Bee Pollen

Ingredients		Content	
Vitamins	Vitamin A	Under analysis	mg/100g
	Vitamin B_1	0.84	mg/100g
	Vitamin B_2	0.97	mg/100g
	Vitamin B_6	0.398	mg/100g
	Vitamin C	4	mg/100g
	Vitamin E	10.5	mg/100g
	Vitamin K_1	1	mg/100g
	Folic acid	1,200	mg/100g
	Pantothenic acid	0.23	mg/100g
	Biotin	8.7	mg/100g
	Inositol	240	mg/100g
	Niacin equivalent	8.64	mg/100g
	Choline	0.26	g/100g
Minerals	Sodium	3.7	mg/100g
	Phosphorus	296	mg/100g
	Iron	2.84	mg/100g
	Calcium	64.7	mg/100g
	Potassium	Under analysis	mg/100g
	Magnesium	47.4	mg/100g
	Copper	0.61	mg/100g
	Zinc	3.43	mg/100g
	Manganese	2.75	mg/100g

Ingredients		Content	
Free amino acids	Arginine	107.2	mg/100g
	Lysine	34.6	mg/100g
	Histidine	87.0	mg/100g
	Phenylalanine	148.7	mg/100g
	Tyrosine	37.5	mg/100g
	Leucine	95.5	mg/100g
	Isoleucine	24.2	mg/100g
	Methionine	32.4	mg/100g
	Valine	41.6	mg/100g
	Alanine	72.9	mg/100g
	Glycine	1.8	mg/100g
	Proline	2,262.3	mg/100g
	Glutamic acid	13.3	mg/100g
	Serine	39.6	mg/100g
	Threonine	25.6	mg/100g
	Aspartic acid	38.6	mg/100g
	Tryptophan	20.7	mg/100g
	Cystine	0.0	mg/100g
	Hydroxyproline	24.3	mg/100g
	γ-aminobutyric acid	64.2	mg/100g
Other ingredients		Flavonoids Fatty acids Sterol	

Data are provided from Reference 1).

isoleucine, and proline. BCAA is easy to become a source of energy and is directly metabolized in the muscles [2], which is a function of improvement of exercise endurance that has been clarified. Proline is a combustion-based amino acid and is known to be a quick-acting energy source. Gamma-aminobutyric acid (GABA) is also known as a substance that relieves mental stress and improves bedridden states and waking up, which suggests that taking this in might improve your sleep quality [3].

Bee pollen is rich in proline and GABA, and contains BCAA, various amino acids, vitamins, etc. comprehensively. From this fact, it was considered that the ingestion of bee pollen by the athlete who practiced the exercise on a daily basis might be effective for the improvement of quality of life and exercise performance.

Therefore, we focused on the effects of continuous ingestion of bee pollen for a period of time on athletes' performance, and investigated changes in body composition, muscle strength, and mental effects. Moreover, since bee pollen contains pollen, we investigated how it affects the symptoms of pollinosis. The purpose of this study is to investigate the effects of bee pollen on athletes' performance and mental aspects, we investigated changes in body composition, muscle endurance, stress, sleep quality, and symptoms of hay fever.

Methods

Study subject

Sixty-one male collegiate rugby players (mean age 21 ± 1 years) were included in the study according to the study plan. They were conditioned on participating in routine practice, being 20 years of age or older, and being healthy. Four of them were unable to participate in the study because they were unable to measure data at the departure or before the start of the study (***Fig. 2***).

Test food

The test foods were chewable tablets containing bee pollen 1g per tablet and their placebos. The main components are shown in ***Table 2***.

Table 2. Ingredients of test foods.

Bee pollen (BP) group	Placebo group
Bee Pollen (powder type)	Reduced malt sugar starch syrup
Honey	Multidextrin
Crystalline cellulose	Sugar
Calcium stearate	Crystalline cellulose
Silicon dioxide	Gardenia yellow dye
	Calcium stearate
	Fine silicon dioxide particles
	Caramel dye

Study Design

The study period was 16 weeks (late February to late June 2018), of which 1 day to 12 weeks were the study diet intake period. The study was double-blinded, and bee pollen and placebos were encapsulated in a bag that was labeled A and B without communicating to the tester which was encapsulated by the test food provider (Api). When assigning

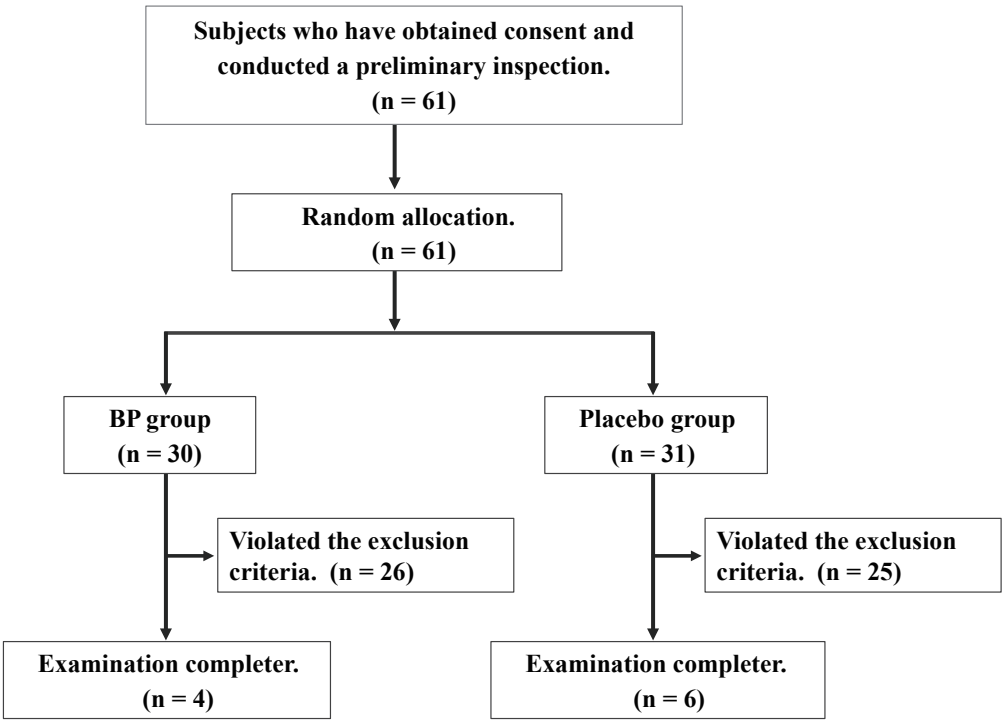

Fig. 2. **Flowchart of clinical studies.**

study subjects, they were stratified according to whether they lived at home, under-house, or dormitory, whether their position moved back or forward, and also considering and stratifying the grade. Within this subgroup, the paper with the ID was made to not be visible in the inside, and then it was randomized in half in each group. The test food provider (Api) provided only food products and was not involved in explaining or analyzing the information to the target audience.

The intake of the test food was 6 tablets per day. The intake time was not specified, and the subjects consumed it at a time of their choosing.

A total of 5 times, including weeks 0, 4, 8, 12, and 16, were surveyed in conference rooms and physical education facilities using body composition measurements, stress checks, GO/NO GO tests, glycation stress measurements, and paper-based Visual Analogue Scale (VAS). They also received weight-training data provided by the study subjects during the same period. A questionnaire survey was conducted via mail once a week.

Of the subjects who completed all of the predetermined study schedules and measurements, those corresponding to the following criteria were excluded from the analysis.

① Individuals who consumed less than sixty percent of test foods
② Persons who left the office during the study period
③ Individuals who were not measured before the start of the study

Details of tests and investigations

Each item is represented by the expression in " " after the results.

1) Measurement of body composition

For body composition measurement, a commercially available body composition meter (BC-722; Tanita, Tokyo, Japan) was used to calculate "muscle mass."

2) Training

Training was performed routinely by each study participant, all of whom received data of muscle power at weeks 0, 4, 8, 12, and 16 prior to the start of the study The data items were "bench press," "squat," "clean," and "dead lift." Bench press assessed limb muscles (upper limb), squat assessed limb muscles (lower limb), clean assessed limb muscles and posterior trunk muscles, and deadlift assessed general muscle power.

3) "Stress Check"

Vital monitoring VM500 (Institute of Fatigue Sciences, Inc., Osaka, Japan) was used for the stress check. The autonomic nervous system balance and autonomic nervous function, which are evaluation criteria of fatigue and stress, were investigated by analyzing heart rate variability from pulse wave and electrocardiogram by thumb diagnostic via measuring instrument. The coefficient of the component variance total power (ccvTP) was used as an evaluation index. The ccvTP shows the function of the autonomic nervous system, which is calculated by correcting the sum of the LF value (sympathetic value) and the HF value (parasympathetic value) called TP (total power) with the heart rate during the time used to measure the LF and HF values.

4) "GO/NO GO"

Brain activity checker (EPC, Inc., Sapporo, Japan) was used for the go/no go decision. The brain activity checker is a measuring instrument with a tablet screen and rubber spheres connected to it. When the red lamp lights on the screen, grasp the rubber ball (TEST1); when the red lamp was lit, the rubber ball was grasped; when the yellow lamp lights,, do not grasp the rubber ball (TEST2); when the red lamp lights, do not grasp the rubber ball; and when the yellow lamp lights grasp the rubber ball (TEST3), the test was performed in three stages, ranging from TEST 1 to 3. This is a type of cognitive test that is used to determine numerically whether they (1) understand it correctly, (2) remember it correctly, (3) judge it correctly, (4) respond quickly, and (5) inhibit unnecessary responses. Eight figures of TEST1 (formative stage experiment), TEST2 (differentiation stage experiment), TEST3 (reversed differentiation stage), the respective mean reaction times, the number of times each in TEST2・TEST3 forgot to grasp and the number of grip mistakes were measured by this test.

5) VAS study

The effects on muscle soreness, stress, and willingness were assessed by a completed questionnaire survey before the start of the study (week 0), at weeks 4, 8, 12, and 16. The questionnaire survey form contains a 10 cm line per survey item, and the survey items are marked linearly according to the patient's own sense of the condition. Then, the position of the mark of each item was counted from the left edge (0 mm) and numericalized (mm) after collecting the survey form. ***Table 3*** also shows the items to be investigated in the VAS and the definitions at both ends of each item.

6) Questionnaire survey

An e-mail questionnaire was sent weekly on Monday for 16 weeks from the start date of the study food intake (Day 0). The questionnaire was developed at Hospital Navi (MS Dream Inc., Nagoya, Japan). Subsequently, an e-mail with a URL attached to the developed questionnaire response form was sent to obtain responses. In addition, the questionnaire items were prepared for each subject so that the course of the symptoms could be checked after having the test subjects answer any of four types of symptoms of pollinosis: none, eye symptoms, nasal symptoms, eye symptoms and nasal symptoms in one case, before sending the initial questionnaire. The questionnaire items, were created with reference to past reports [3-12], and are shown in ***Table 4***.

Statistical analysis

All measured values ,and test results were expressed as mean ± standard deviation, with a change of 0 before the start of ingestion (week 0).

Table 3. VAS survey items.

Survey items	0 mm (far left)	100 mm (far right)
① "Degree of general pain such as myalgia and arthralgia" in the last week.	No condition	Almost always feel
② 'Physical stress' in the last week.	No condition	The strongest state to date
③ 'Mental stress' in the last week.	No condition	The strongest state to date
④ "Willingness, energy, and level of willingness and desire to do something" over the past week.	No condition	The strongest state to date

In all items, the analysis was performed using SPSS ver. 25. The t-test and Wilcoxon signed-rank test were used for comparisons between Bee Pollen group (the BP group) and the placebo group at each time point. Wilcoxon signed rank tests were used for muscle mass, t-tests for training, VAS-surveys, stress checks, and questionnaires [8] using t-tests and Mann-Whitney tests for comparisons at the beginning of the sampling period (week 0) and at the ending of the sampling period. Mann-Whitney tests were performed for muscle mass, t-tests for training, VAS-surveys, stress checks, and questionnaires.

When analyzing the results of a weekly questionnaire survey, each choice chosen by the study subjects was scored as shown in ***Table 4*** for analysis.

Ethical standards

Prior to the test, the purpose of the test and expected effects were explained to the subjects. The outline of the study food, information on side effects (allergy, itchiness, soreness, stress, sleeplessness) which may be generated by test food intake were provided, and it was also explained that the medical expenditure was paid, if a problem arose. In addition, consent was obtained by a consent form for participation in the study. This study complied with the ethical guidelines for research in medicine involving human subjects (announced by the Ministry of Education, Culture, Sports, Science and Science and the Ministry of Health, Labour and Welfare). In order to ensure the human rights, and safety of the subjects, and the reliability of the test data, the Ethical Review Board on Research Involving People at Doshisha Women's University was reviewed and approved (approval number: 2017-30).

Results

The numbers of patients included in the analysis who consumed at least sixty percent bee Pollen or placebos are shown in the table below (***Table 5***). The following shows the results of the analysis, excluding those who had a sampling rate of less than six percent during the first two months, without considering the acceptance rate of food after three months.

1) "Muscle mass"

Data varying more than 2 kg over 4 weeks were excluded. Comparison with the baseline group showed no significant difference, whereas comparison between groups showed a significant increase in the BP group at 5% risk compared with the placebo group at weeks 4 and 8. There was no increasing trend in the placebo group over the 16-week period, compared with an increase over time in the BP group (***Table 6, Fig. 3***).

2) Training

Data at the start and week 4 of intake were analyzed because no data were available after week 8. There were no significant differences in any of the changes in muscle power over time or between-group comparisons in all four parameters (***Table 7, Fig. 4***).

3) Stress Check

The placebo-treated group had a significant reduction in ccvTP levels at 5% risk at 8 weeks compared with the baseline. There were no significant differences between the groups (***Table 8, Fig. 5***).

4) "GO/NO GO"

The placebo group did not differ significantly in terms of the rate of correct answers between before and at week 4 of intake. There was also no significant difference between the groups. However, the BP group could not be analyzed due to a shortage of respondents. Since failure occurred in the machinery at week 8, the data were not measured correctly thereafter (***Table 9***).

5) VAS study (Table 10)

The "level of systemic pain such as myalgia and arthralgia" was significantly decreased by 5% at 4 weeks and 8 weeks compared with before the start of intake only in the placebo group. There was no significant difference between the groups.

Physical stress was significantly reduced in the placebo group at 5% risk at week 4 compared with before intake only. Between-group comparisons showed a significant reduction in the risk of 5% in the BP group compared with the placebo group at week 4.

There were no significant differences in mental stress between the groups and between the groups before the start of ingestion.

There was no significant difference in the level of willingness, vitality, and intention and desire to do anything between the groups.

6) Questionnaire survey

Locations where data were not available and where they could not be analysed due to a lack of respondents are indicated by ***Tables 11***.

For ⑧"Difficult to think," only in the placebo group, the risk was significantly reduced at week 11 by 5% compared with before the start of ingestion.

There were no significant differences in changes over time or between-group comparisons for items other than⑧ "Difficult to think."

For ⑫ "degree of itching of the eyes" and ⑬ "degree of tearing," no data of the BP group were obtained.

Table 4. Questionnaire items and scores.

Item		Scores and Options	
1	How long was the average time from laying in bed to falling sleep in the past week? → "Falling aslseep time"	1 2 3 4 5 6 7 8 9	0 min ～ 10 min ～ 20 min ～ 30 min ～ 40 min ～ 50 min ～ 60 min ～ 2 hours ～ 2 hours or more
2	On average, how many times have you awakened during the middle of the night or sleep during the week? → "Waking in the middle"	1 2 3 4 5	0 times Once 2 times 3 times 4 times or more
3	What do you feel about the overall quality of sleep in the week?	1 2 3 4	Satisfied A little dissatisfied Considerably inadequate There was no sleep at all
4	I would like to ask about your condition for the past week. How irritable we you?	1 2 3 4 5	Not applicable Slightly A little Considerably Very much
5	I would like to ask about your condition for the past week. How much did "I feel uncomfortable"?	1 2 3 4 5	Not applicable Slightly A little Considerably Very much
6	I would like to ask about your condition for the past week. To what extent did you feel anxious?	1 2 3 4 5	Not applicable Slightly A little Considerably Very much
7	I would like to ask about your condition for the past week. How well do you agree with "I feel depressed"?	1 2 3 4 5	Not at all applicable Slightly A little Considerably Very much
8	I would like to ask about your condition for the past week. How much was it "difficult to put together thoughts"?	1 2 3 4 5	Not applicable Slightly A little Considerably Very much
9	How many sneezes on average a day in the past week? → 'Number of sneezes'.	1 2 3 4 5	0 times 1-5 times 6-10 times 11-20 times 21 times or more
10	How many times did you blown your nose each day in the past week on average? → 'Number of nose blows'.	1 2 3 4 5	0 times 1-5 times 6-10 times 11-20 times 21 times or more
11	How often was your nose congested in the past week? → "Degree of nasal congestion"	1 2 3 4 5	No congested nose There was no mouth breathing, but there was nasal congestion There was nose congestion from time to time There was nose congestion significant respiration difficulty The nose congestion never ceased
12	In this week, how much did your eyes itch? → "The degree of itching of the eye"	1 2 3 4 5	None Not enough to rub Sometimes rubbed Rubbed often Unable to stop rubbing
13	How often did you eyes tear in the past week? → "Degree of tear"	1 2 3 4 5	None Not enough to wipe Occasionally had to wipe Recurring tears Puffy tears
14	In the past week, how was the degree of interference with daily life caused by hay fever?	1 2 3 4 5	No problem A little unfortunate Not distressing, but somewhat disruptive Very disruptive Totally impossible
15	Choose from the following numbers for the last week's Subjective Exercise Intensity (how tight you felt during your exercise).	20 19 18 17 16 15 14 13 12 11 10 9 8 7 6	 Very tight Fairly tight Tight Slightly tight Comfortable Fairly comfortable Very comfortable

Table 5. Number of patients included in the analysis.

	1 month	2 month	3 month
BP Group	9	4	1
Placebo group	13	6	0
Total	22	10	1

Table 6. Muscle mass.

		BP group		Placebo group		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
		Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
Muscle mass	Week 4	0.43 ± 0.31	3	-0.04 ± 0.33	5	0.186	0.818	0.030
	Week	0.80 ± 0.20	2	-0.13 ± 0.39	6	0.156	0.479	0.034
	Week 12	1.40 ± 0.60	2	-0.22 ± 0.59	5	0.258	0.500	0.087
	Week 16	1.70 ± 0.00	1	-0.38 ± 0.95	5	–	0.468	

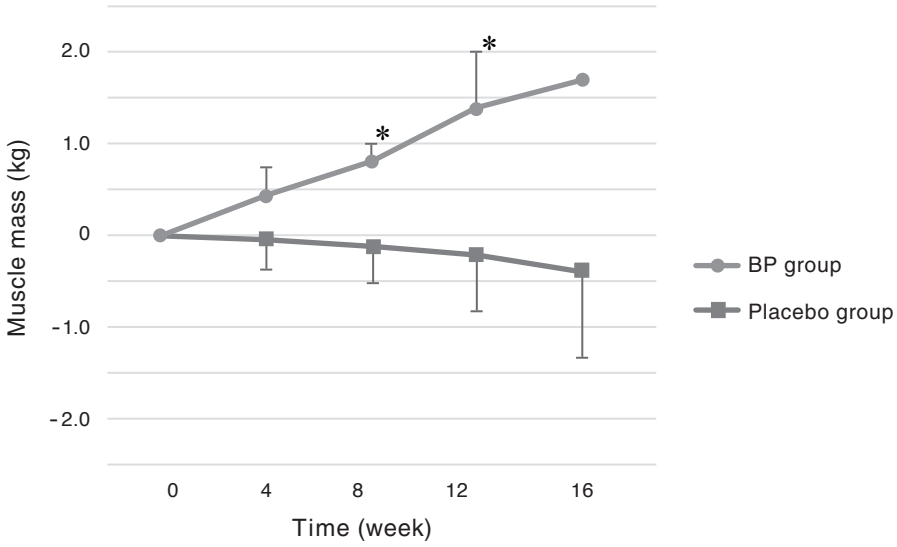

***Fig. 3.* Changes in muscle mass over time.**

Results are expressed as mean ± SD, * $p < 0.05$ by Wilcoxon test from Placebo group (n = 5～6). BP group (n = 1～3), BP, Bee pollen; SD, standard deviation.

Table 7. Training.

	Bee Pollen group		Placebo group		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
	Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
"Bench press"	1.88 ± 3.25	4	-1.67 ± 8.50	6	0.391	0.679	0.070
"Squat"	-5.00 ± 29.58	4	15.93 ± 21.89	6	0.785	0.164	0.078
"Clean"	-10.00 ± 9.35	4	-1.27 ± 5.39	6	0.161	0.622	0.149
"Dead lift"	-13.13 ± 27.45	4	-2.08 ± 12.94	6	0.469	0.734	0.313

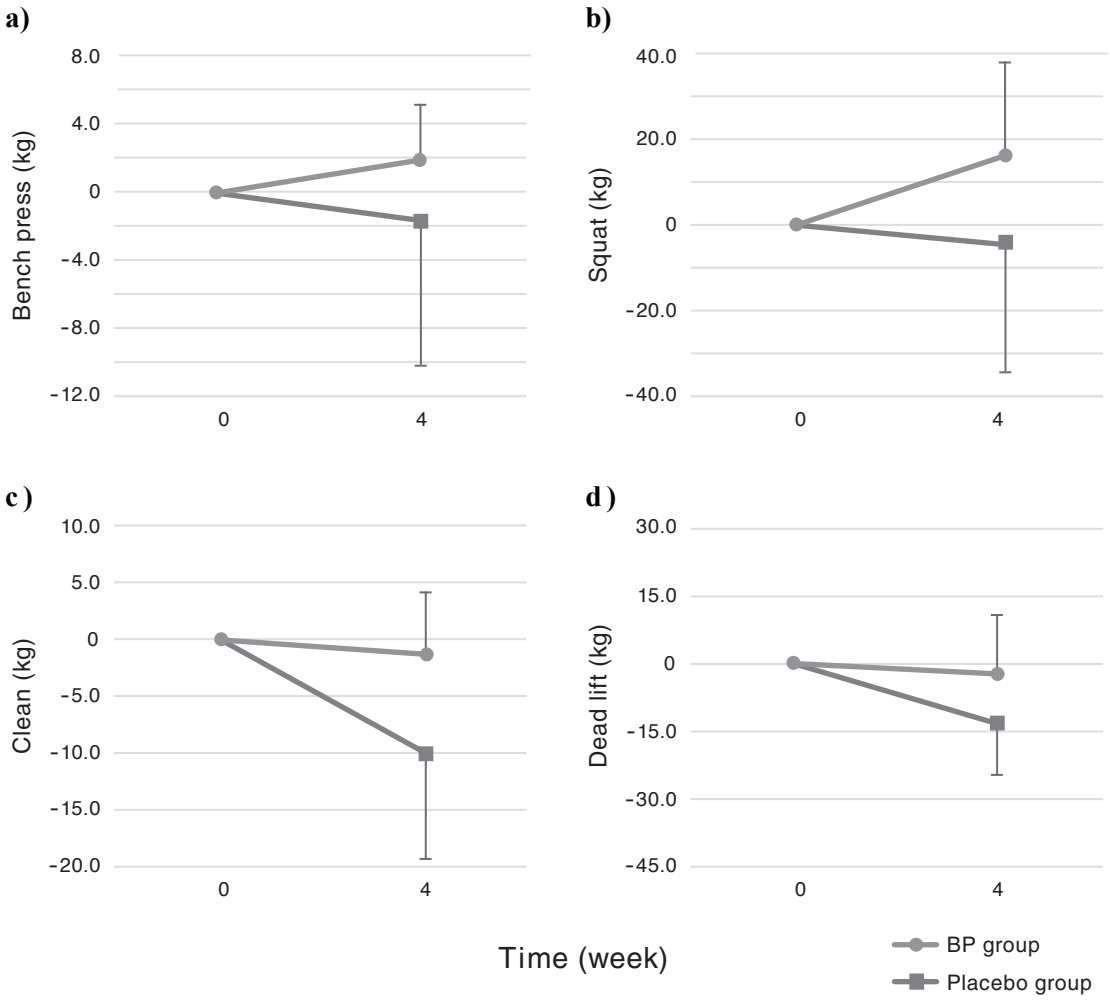

Fig. 4. **Changes in muscle power over time.**

a) Bench press, **b)** Squat, **c)** Clean, **d)** Dead lift. Results are expressed as mean ± SD. BP group, n = 4; Placebo group, n = 6; BP, Bee pollen; SD, standard deviation.

Table 8. Stress check.

		BP group		Placebo group		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
		Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
ccvTP	Week 4	0.24 ± 0.56	2	0.18 ± 1.01	4	0.655	0.715	1.000
	Week	-0.46 ± 1.39	3	-2.11 ± 1.97	5	0.593	0.043*	0.250
	Week 12	1.03 ± 0.41	3	0.68 ± 2.05	4	0.109	0.715	0.629
	Week 16	1.56 ± 1.28	2	0.09 ± 3.53	5	0.180	0.500	0.381

ccVTP, coefficient of component variance total power.

Table 9. "GO/NO GO".

	BP group		Placebo group		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
	Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
Rate of correct answers	0.00 ± 0.00	1	0.00 ± 0.04	2	–	0.317	0.667

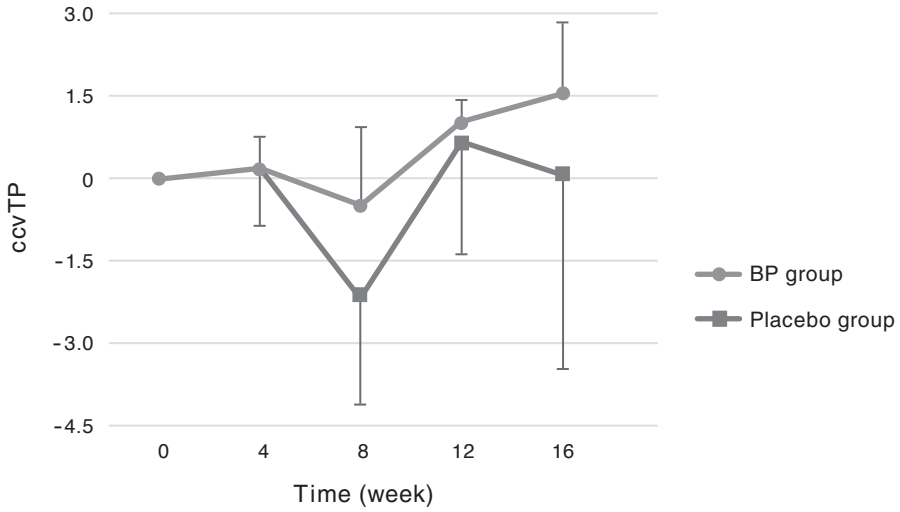

Fig. 5. **Changes in "Stress Check" over time.**

Results are expressed as mean ± SD. BP group, n = 2～3; Placebo group, n = 4～5; ccVTP, coefficient of component variance total power; BP, Bee pollen; SD, standard deviation.

Table 10. VAS survey.

① What was the degree of general pain, such as myalgia and arthralgia, in the last week?
② What was the "physical stress" in the last week?
③ How have you been experiencing "mental stress" over the past week?
④ How was the "degree of willingness and desire to do something" in the past week?

		BP group (mm)		Placebo group (mm)		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
		Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
①	Week 4	-51.13 ± -9.13	4	-43.30 ± 25.55	5	0.068	0.043*	0.556
	Week 8	-35.25 ± 17.56	4	-24.75 ± 14.54	6	0.068	0.028*	0.352
	Week 12	-9.67 ± 15.15	3	-8.70 ± 11.38	5	0.414	0.138	1.000
	Week 16	-23.00 ± 6.00	2	-30.10 ± 27.53	5	0.180	0.080	0.857
②	Week 4	-51.88 ± 3.25	4	-26.20 ± 18.38	5	0.068	0.043*	0.032#
	Week 8	-29.13 ± 19.31	4	-11.50 ± 32.38	6	0.068	0.753	0.476
	Week 12	-2.67 ± 4.92	3	1.10 ± 21.98	5	0.593	0.686	0.393
	Week 16	-21.00 ± 7.00	2	-18.30 ± 25.75	5	0.180	0.138	0.857
③	Week 4	-16.38 ± 26.21	4	8.20 ± 23.75	5	0.273	0.500	0.413
	Week 8	-4.88 ± 11.52	4	-0.33 ± 21.93	6	0.715	0.753	0.476
	Week 12	1.17 ± 28.72	3	17.80 ± 31.35	5	1.000	0.345	0.786
	Week 16	-23.50 ± 8.50	2	14.00 ± 19.73	5	0.180	0.225	0.095
④	Week 4	-0.13 ± 7.81	4	-12.70 ± 29.20	5	1.000	0.686	0.905
	Week 8	4.13 ± 20.16	4	-6.92 ± 20.48	6	0.715	0.600	0.762
	Week 12	3.83 ± 17.37	3	-19.90 ± 13.05	5	0.593	0.043*	0.250
	Week 16	-8.25 ± 32.75	2	-7.10 ± 11.92	5	0.655	0.345	1.000

Table 11. Questionnaire survey.

① How long was the average time from laying in bed to falling asleep in the past week?
1: 0 min, 2: ~10 min, 3: ~20 min, 4: ~30 min, 5: ~40 min,
6: 50 min, 7: ~60 min 8: ~2 hr, 9: 2 hr or more

② On average, how many times have you awakened during the middle of the night or sleep during the week?
1: 0 times, 2: 1 times, 3: 2 times, 4: 3 times, 5: 4 times or more

③ What do you feel about the overall quality of sleep in the week?
1: Satisfied, 2: Somewhat dissatisfied, 3: Fairly unsatisfactory, 4: Completely unsatisfied, or unable to sleep at all

④ I would like to ask about your condition for the past week. How irritable were you?
1: Not at all true, 2: Slightly true, 3: Somewhat true,
4: Quite true, 5: Very true

⑤ I would like to ask about your condition for the past week. How much did "I feel uncomfortable"?
1: Not at all true, 2: Slightly true, 3: Somewhat true,
4: Quite true, 5: Very true

⑥ I would like to ask about your condition for the past week. To what extent did you feel anxious?
1: Not at all true, 2: Slightly true, 3: Somewhat true,
4: Quite true, 5: Very true

⑦ I would like to ask about your condition for the past week. How well do you agree with "I feel depressed"?
1: Not at all true, 2: Slightly true, 3: Somewhat true,
4: Quite true, 5: Very true

⑧ I would like to ask about your condition for the past week. How much was it "difficult to put together thoughts"?
1: Not at all true, 2: Slightly true, 3: Somewhat true,
4: Quite true, 5: Very true

⑨ How many times did you sneeze on average a day in the past week?
1: 0 times, 2: 1-5 times, 3: 6-10 times, 4: 11-20 times, 5: 21 times or more

⑩ How many times have you blown your nose each day in the past week on average?
1: 0 times, 2: 1-5 times, 3: 6-10 times, 4: 11-20 times, 5: 21 times or more

⑪ How long has your nose been congested in the past week?
1: No congestion, 2: No mouth breathing but some congestion, 3: Congestion and occasional mouth breathing
4: Congestion and considerable mouth breathing, 5: Completely congested

⑫ In this week, how often did your eyes itch?
1: None, 2: Not enough to rub, 3: occasional rubbing,
4: Frequent rubbing, 5: Cannot stop rubbing

⑬ How much did your eyes tear in the past week?
1: None; 2: Not enough to wipe; 3: Occasional tears; 4: Often tears; 5: Puffy tears

⑭ In the past week, how much did hay fever interfere with daily life?
1: No problem, 2: Very acceptable, 3: Not distressing but somewhat disruptive,
4: Disruptive, 5: Impossible

⑮ Choose your subjective exercise intensity for the past week (how tight you felt during exercise)
from the following numbers.
20, 19: Very tight, 18, 17: Fairly tight, 16, 15: Tight, 14, 13: Somewhat tight,
12, 11: Comfortable, 10, 9: Fairly comfortable, 8, 7: Very comfortable, 6

		BP group		Placebo group		Comparison with pre-ingestion (p-value).		Comparison between groups (p-value)
		Mean ± SD	n	Mean ± SD	n	BP group	Placebo	
①	Week 1	0.50 ± 0.50	4	0.75 ± 0.83	4	0.157	0.180	0.886
	Week 2	0.00 ± 0.82	3	-1.00 ± 1.26	5	1.000	0.180	0.393
	Week 3	-0.33 ± 0.94	3	-0.75 ± 1.30	4	0.564	0.317	1.000
	Week 4	-0.33 ± 0.94	3	-1.50 ± 1.50	4	0.564	0.157	0.629
	Week 5	-0.25 ± 0.83	4	0.00 ± 0.00	3	0.564	1.000	0.629
	Week 6	-0.33 ± 0.94	3	-0.75 ± 0.83	4	0.564	0.180	0.857
	Week 7	0.00 ± 0.82	3	0.00 ± 0.71	4	1.000	1.000	1.000
	Week 8	-0.25 ± 0.83	4	-0.50 ± 1.50	4	0.564	0.655	0.886
	Week 9	0.33 ± 1.25	3	-0.50 ± 2.18	4	0.655	0.655	0.857
	Week 10	-0.25 ± 0.83	4	-0.75 ± 1.30	4	0.564	0.317	0.886
	Week 11	-0.33 ± 0.47	3	-1.60 ± 1.85	5	0.317	0.109	0.393
	Week 12	1.00 ± 0.00	2	-1.00 ± 2.45	4	0.157	0.705	0.533
	Week 13	-0.50 ± 0.50	2	-1.50 ± 2.06	4	0.317	0.180	0.800
	Week 14	0.50 ± 0.50	2	-1.25 ± 2.28	4	0.317	0.414	0.533
	Week 15	-0.50 ± 0.50	2	0.33 ± 1.25	3	0.317	0.655	0.800
	Week 16	0.00 ± 1.22	4	-0.75 ± 0.83	4	1.000	0.180	0.686
②	Week 1	-0.75 ± 0.83	4	0.25 ± 0.43	4	0.180	0.317	0.200
	Week 2	0.00 ± 0.00	3	-0.20 ± 0.40	5	1.000	0.317	0.786
	Week 3	0.00 ± 0.00	3	0.25 ± 0.43	4	1.000	0.317	0.629
	Week 4	0.00 ± 0.00	3	-0.50 ± 0.87	4	1.000	0.317	0.629
	Week 5	-0.25 ± 0.43	4	0.00 ± 0.00	3	0.317	1.000	0.629
	Week 6	0.00 ± 0.00	3	0.25 ± 0.43	4	1.000	0.317	0.629
	Week 7	0.00 ± 0.00	3	0.25 ± 0.43	4	1.000	0.317	0.629
	Week 8	-0.50 ± 0.87	4	0.50 ± 1.12	4	0.317	0.414	0.343
	Week 9	0.00 ± 0.00	3	0.00 ± 0.00	4	1.000	1.000	1.000
	Week 10	-0.25 ± 1.09	4	0.50 ± 0.87	4	0.655	0.317	0.686
	Week 11	0.00 ± 0.00	3	0.40 ± 0.80	5	1.000	0.317	0.786
	Week 12	1.00 ± 0.00	2	0.75 ± 0.83	4	0.157	0.180	0.800
	Week 13	1.00 ± 1.00	2	0.25 ± 0.43	4	0.317	0.317	0.533
	Week 14	0.50 ± 0.50	2	0.50 ± 0.87	4	0.317	0.317	0.800
	Week 15	0.00 ± 0.00	2	0.00 ± 0.00	3	1.000	1.000	1.000
	Week 16	-0.50 ± 0.87	4	0.25 ± 1.09	4	0.317	0.655	0.686
③	Week 1	0.00 ± 0.00	4	0.00 ± 0.71	4	1.000	1.000	1.000
	Week 2	0.00 ± 0.00	3	0.20 ± 0.40	5	1.000	0.317	0.786
	Week 3	0.00 ± 0.82	3	-0.50 ± 0.50	4	1.000	0.157	0.629
	Week 4	0.33 ± 0.47	3	-0.25 ± 0.43	4	0.317	0.317	0.400
	Week 5	-0.50 ± 0.50	4	-0.33 ± 0.47	3	0.157	0.317	0.857
	Week 6	-0.33 ± 0.47	3	0.00 ± 0.71	4	0.317	1.000	0.629
	Week 7	0.00 ± 0.00	3	0.25 ± 0.43	4	1.000	0.317	0.629
	Week 8	-0.50 ± 0.50	4	0.25 ± 0.43	4	0.157	0.317	0.200
	Week 9	0.67 ± 0.47	3	0.25 ± 0.43	4	0.157	0.317	0.400
	Week 10	0.00 ± 0.00	4	-0.25 ± 0.43	4	1.000	0.317	0.686
	Week 11	0.00 ± 0.00	3	-0.20 ± 0.75	5	1.000	0.564	0.786
	Week 12	-0.50 ± 0.50	2	0.00 ± 1.22	4	0.317	1.000	0.800
	Week 13	0.00 ± 0.00	2	-0.50 ± 0.50-	4	1.000	0.157	0.533
	Week 14	-0.50 ± 0.50	2	-0.25 ± 0.83	4	0.317	0.564	0.800
	Week 15	0.00 ± 0.00	2	-0.33 ± 0.47	3	1.000	0.317	0.800
	Week 16	-0.25 ± 0.43	4	0.25 ± 0.83	4	0.317	0.564	0.486

④	Week 1	-0.75 ± 0.83	4	-0.25 ± 0.83	4	0.180	0.564	0.686
	Week 2	-0.33 ± 0.47	3	-0.40 ± 0.49	5	0.317	0.157	1.000
	Week 3	-0.67 ± 0.47	3	-0.50 ± 0.50	4	0.157	0.157	0.857
	Week 4	0.00 ± 0.00	3	-0.50 ± 0.50	4	1.000	0.157	0.400
	Week 5	-1.00 ± 0.71	4	0.00 ± 0.82	3	0.102	1.000	0.229
	Week 6	-0.67 ± 0.47	3	-0.50 ± 0.50	4	0.157	0.157	0.857
	Week 7	-0.33 ± 0.47	3	-0.75 ± 0.43	4	0.317	0.083	0.400
	Week 8	-0.50 ± 0.87	4	0.00 ± 1.00	4	0.317	1.000	0.686
	Week 9	-0.33 ± 0.47	3	-0.75 ± 0.43	4	0.317	0.083	0.400
	Week 10	-0.50 ± 0.50	4	0.25 ± 0.83	4	0.157	0.564	0.343
	Week 11	-0.67 ± 0.47	3	-0.20 ± 0.75	5	0.157	0.564	0.571
	Week 12	0.00 ± 0.00	2	0.00 ± 1.22	4	1.000	1.000	0.800
	Week 13	-1.50 ± 0.50	2	-0.25 ± 0.83	4	0.180	0.564	0.267
	Week 14	-2.00 ± 0.00	2	-0.25 ± 0.43	4	0.157	0.317	0.133
	Week 15	-0.50 ± 0.50	2	-0.67 ± 0.47	3	0.317	0.157	0.800
	Week 16	-0.50 ± 0.50	4	-0.50 ± 0.50	4	0.157	0.157	1.000
⑤	Week 1	-0.50 ± 0.50	4	-0.25 ± 0.83	4	0.157	0.564	0.886
	Week 2	-0.67 ± 0.47	3	0.20 ± 0.75	5	0.157	0.564	0.250
	Week 3	-0.33 ± 0.47	3	0.00 ± 0.71	4	0.317	1.000	0.629
	Week 4	-0.33 ± 0.47	3	-0.25 ± 1.09	4	0.317	0.655	0.857
	Week 5	-0.75 ± 0.43	4	-0.67 ± 0.94	3	0.083	0.317	0.857
	Week 6	0.00 ± 0.82	3	-0.50 ± 0.87	4	1.000	0.317	0.629
	Week 7	0.33 ± 0.47	3	-0.50 ± 1.12	4	0.317	0.414	0.400
	Week 8	-0.25 ± 0.43	4	0.25 ± 1.09	4	0.317	0.655	0.686
	Week 9	0.33 ± 0.47	3	0.50 ± 1.12	4	0.317	0.414	0.857
	Week 10	-0.50 ± 0.50	4	-0.50 ± 1.12	4	0.157	0.414	1.000
	Week 11	-0.33 ± 0.47	3	-0.20 ± 0.98	5	0.317	0.655	0.786
	Week 12	0.00 ± 0.00	2	-0.50 ± 0.87	4	1.000	0.317	0.800
	Week 13	-0.50 ± 0.50	2	-0.50 ± 0.87	4	0.317	0.317	0.800
	Week 14	-0.50 ± 0.50	2	-0.25 ± 0.43	4	0.317	0.317	0.800
	Week 15	0.50 ± 0.50	2	-0.67 ± 0.94	3	0.317	0.317	0.400
	Week 16	-0.25 ± 0.83	4	-0.50 ± 0.87	4	0.564	0.317	-0.886
⑥	Week 1	0.00 ± 0.00	4	0.00 ± 0.00	4	1.000	1.000	1.000
	Week 2	0.33 ± 0.47	3	-0.20 ± 0.40	5	0.317	0.317	0.393
	Week 3	0.67 ± 0.47	3	0.50 ± 0.87	4	0.157	0.317	0.629
	Week 4	0.00 ± 0.00	3	0.25 ± 0.43	4	1.000	0.317	0.629
	Week 5	0.25 ± 0.43	4	-0.33 ± 0.47	3	0.317	0.317	0.400
	Week 6	0.67 ± 0.47	3	-0.25 ± 0.43	4	0.157	0.317	0.114
	Week 7	1.33 ± 0.94	3	0.00 ± 0.00	4	0.157	1.000	0.229
	Week 8	0.50 ± 0.50	4	0.50 ± 0.87	4	0.157	0.317	0.886
	Week 9	1.00 ± 0.82	3	0.75 ± 1.30	4	0.180	0.317	0.629
	Week 10	0.50 ± 0.87	4	1.00 ± 0.71	4	0.317	0.102	0.486
	Week 11	0.67 ± 0.47	3	0.40 ± 0.49	5	0.157	0.157	0.571
	Week 12	0.00 ± 0.00	2	-0.25 ± 1.09	4	1.000	0.655	1.000
	Week 13	0.00 ± 0.00	2	0.25 ± 0.43	4	1.000	0.317	0.800
	Week 14	0.50 ± 0.50	2	-0.25 ± 0.43	4	0.317	0.317	0.267
	Week 15	0.50 ± 0.50	2	0.33 ± 2.05	3	0.317	0.655	0.800
	Week 16	-0.25 ± 0.43	4	-0.50 ± 0.87	4	0.317	0.317	0.886

⑦	Week 1	0.00 ± 0.71	4	0.00 ± 0.00	4	1.000	1.000	1.000
	Week 2	1.00 ± 0.82	3	-0.20 ± 0.40	5	0.180	0.157	0.143
	Week 3	0.33 ± 0.47	3	-0.25 ± 0.43	4	0.317	0.066	0.400
	Week 4	-0.67 ± 0.47	3	0.25 ± 0.83	4	0.157	0.564	0.229
	Week 5	0.25 ± 0.43	4	0.33 ± 0.47	3	0.317	0.705	0.857
	Week 6	0.00 ± 1.63	3	0.25 ± 0.43	4	1.000	0.380	0.857
	Week 7	0.00 ± 0.82	3	0.00 ± 0.00	4	1.000	0.453	1.000
	Week 8	0.00 ± 0.71	4	0.75 ± 0.83	4	1.000	0.180	0.343
	Week 9	0.33 ± 1.25	3	0.25 ± 0.43	4	0.655	0.102	0.857
	Week 10	0.00 ± 0.71	4	0.50 ± 0.87	4	1.000	0.317	0.686
	Week 11	0.33 ± 1.25	3	0.00 ± 0.40	5	0.655	0.564	1.000
	Week 12	-0.50 ± 0.50	2	0.00 ± 0.71	4	0.317	0.180	0.533
	Week 13	-1.50 ± 0.50	2	-0.25 ± 0.43	4	0.180	0.180	0.133
	Week 14	-0.50 ± 1.50	2	0.00 ± 0.71	4	0.655	0.276	0.800
	Week 15	0.00 ± 0.00	2	0.00 ± 0.00	3	1.000	0.414	1.000
	Week 16	-0.25 ± 0.43	4	0.50 ± 0.87	4	0.317	0.317	0.343
⑧	Week 1	0.00 ± 0.00	4	-1.00 ± 0.71	4	1.000	1.000	0.114
	Week 2	0.33 ± 0.47	3	-0.60 ± 0.49	5	0.317	0.317	0.143
	Week 3	0.33 ± 0.47	3	-0.75 ± 0.43	4	0.317	0.317	0.114
	Week 4	0.00 ± 0.00	3	-0.75 ± 0.43	4	1.000	0.564	0.114
	Week 5	0.00 ± 0.00	4	0.00 ± 0.82	3	1.000	0.317	1.000
	Week 6	0.00 ± 0.00	3	-0.25 ± 0.43	4	1.000	0.317	0.629
	Week 7	0.00 ± 0.00	3	-0.25 ± 0.43	4	1.000	1.000	0.629
	Week 8	0.25 ± 0.43	4	0.50 ± 0.50	4	0.317	0.180	0.686
	Week 9	0.00 ± 0.00	3	-0.75 ± 0.43	4	1.000	0.317	0.114
	Week 10	0.50 ± 0.87	4	-0.25 ± 0.43	4	0.317	0.317	0.343
	Week 11	0.00 ± 0.00	3	-0.80 ± 0.40	5	1.000	0.046*	0.071
	Week 12	1.50 ± 1.50	2	-1.00 ± 0.71	4	0.317	1.000	0.133
	Week 13	0.00 ± 0.00	2	-1.00 ± 0.71	4	1.000	0.317	0.267
	Week 14	0.00 ± 0.00	2	-1.00 ± 0.71	4	1.000	1.000	0.267
	Week 15	0.00 ± 0.00	2	-1.00 ± 0.82	3	1.000	1.000	0.400
	Week 16	0.25 ± 0.43	4	-0.50 ± 0.50	4	0.317	0.157	0.200
⑨	Week 1	0.00 ± 1.00	2	1.00 ± 0.00	1	1.000	-	0.667
	Week 2	1.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 3	1.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 4	0.00 ± 0.00	1	-	0	-	-	-
	Week 5	-0.50 ± 0.50	2	0.00 0.00	1	0.317	-	0.667
	Week 6	0.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 7	1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 8	0.00 ± 1.00	2	0.00 ± 0.00	1	1.000	-	1.000
	Week 9	2.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 10	0.50 ± 0.50	2	0.00 ± 0.00	1	0.317	-	0.667
	Week 11	2.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 12	-	0	-	0	-	-	-
	Week 13	0.00 ± 0.00	1	-	0	-	-	-
	Week 14	0.00 ± 0.00	1	-	0	-	-	-
	Week 15	1.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 16	1.00 ± 0.00	2	-1.00 ± 0.00	1	0.157	-	0.667

⑩	Week 1	-0.50 ± 0.50	2	1.00 ± 0.00	1	0.317	-	0.667
	Week 2	1.00 ± 0.00	1	2.00 ± 0.00	1	-	-	1.000
	Week 3	1.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 4	1.00 ± 0.00	1	-	0	-	-	-
	Week 5	0.50 ± 0.50	2	2.00 ± 0.00	1	0.317	-	0.667
	Week 6	1.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 7	1.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 8	0.00 ± 1.00	2	0.00 ± 0.00	1	1.000	-	1.000
	Week 9	1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 10	0.50 ± 0.50	2	0.00 ± 0.00	1	0.317	-	0.667
	Week 11	1.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 12	-	0	-	0	-	-	-
	Week 13	-2.00 ± 0.00	1	-	0	-	-	-
	Week 14	-3.00 ± 0.00	1	-	0	-	-	-
	Week 15	1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 16	0.50 ± 0.50	2	0.00 ± 0.00	1	0.317	-	0.667
⑪	Week 1	-1.00 ± 0.00	2	2.00 ± 0.00	1	0.157	-	0.667
	Week 2	1.00 ± 0.00	1	2.00 ± 0.00	1	-	-	1.000
	Week 3	-1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 4	0.00 ± 0.00	1	-	0	-	-	-
	Week 5	0.00 ± 0.00	2	2.00 ± 0.00	1	1.000	-	0.667
	Week 6	0.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 7	0.00 ± 0.00	1	2.00 ± 0.00	1	-	-	1.000
	Week 8	-0.50 ± 0.50	2	1.00 ± 0.00	1	0.317	-	0.667
	Week 9	0.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 10	0.00 ± 0.00	2	0.00 ± 0.00	1	1.000	-	1.000
	Week 11	0.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 12	-	0	-	0	-	-	-
	Week 13	0.00 ± 0.00	1	-	0	-	-	-
	Week 14	0.00 ± 0.00	1	-	0	-	-	-
	Week 15	0.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 16	-0.50 ± 0.50	2	0.00 ± 0.00	1	0.317	-	0.667
⑫	Week 1	-	0	1.00 ± 0.00	1	-	-	-
	Week 2	-	0	0.00 ± 0.00	1	-	-	-
	Week 3	-	0	0.00 ± 0.00	1	-	-	-
	Week 4	-	0	-	0	-	-	-
	Week 5	-	0	0.00 ± 0.00	1	-	-	-
	Week 6	-	0	0.00 ± 0.00	1	-	-	-
	Week 7	-	0	1.00 ± 0.00	1	-	-	-
	Week 8	-	0	-1.00 ± 0.00	1	-	-	-
	Week 9	-	0	-1.00 ± 0.00	1	-	-	-
	Week 10	-	0	-2.00 ± 0.00	1	-	-	-
	Week 11	-	0	0.00 ± 0.00	1	-	-	-
	Week 12	-	0	-	0	-	-	-
	Week 13	-	0	-	0	-	-	-
	Week 14	-	0	-	0	-	-	-
	Week 15	-	0	-2.00 ± 0.00	1	-	-	-
	Week 16	-	0	-2.00 ± 0.00	1	-	-	-

⑬	Week 1	-	0	1.00 ± 0.00	1	-	-	-
	Week 2	-	0	2.00 ± 0.00	1	-	-	-
	Week 3	-	0	1.00 ± 0.00	1	-	-	-
	Week 4	-	0	-	0	-	-	-
	Week 5	-	0	2.00 ± 0.00	1	-	-	-
	Week 6	-	0	1.00 ± 0.00	1	-	-	-
	Week 7	-	0	1.00 ± 0.00	1	-	-	-
	Week 8	-	0	0.00 ± 0.00	1	-	-	-
	Week 9	-	0	0.00 ± 0.00	1	-	-	-
	Week 10	-	0	0.00 ± 0.00	1	-	-	-
	Week 11	-	0	0.00 ± 0.00	1	-	-	-
	Week 12	-	0	-	0	-	-	-
	Week 13	-	0	-	0	-	-	-
	Week 14	-	0	-	0	-	-	-
	Week 15	-	0	0.00 ± 0.00	1	-	-	-
	Week 16	-	0	0.00 ± 0.00	1	-	-	-
⑭	Week 1	-0.50 ± 0.50	2	1.00 ± 0.00	1	-	-	0.667
	Week 2	0.00 ± 0.00	1	1.00 ± 0.00	1	-	-	1.000
	Week 3	-1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 4	-1.00 ± 0.00	1	-	0	-	-	-
	Week 5	-1.00 ± 0.00	2	0.00 ± 0.00	1	-	-	0.667
	Week 6	-1.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 7	-2.00 ± 0.00	1	0.00 ± 0.00	1	-	-	1.000
	Week 8	-1.50 ± 0.50	2	0.00 ± 0.00	1	-	-	0.667
	Week 9	-1.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 10	-1.00 ± 0.00	2	-1.00 ± 0.00	1	-	-	1.000
	Week 11	-2.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 12	-	0	-	0	-	-	-
	Week 13	-1.00 ± 0.00	1	-	0	-	-	-
	Week 14	-2.00 ± 0.00	1	-	0	-	-	-
	Week 15	-2.00 ± 0.00	1	-1.00 ± 0.00	1	-	-	1.000
	Week 16	-1.50 ± 0.50	2	-1.00 ± 0.00	1	-	-	0.667
⑮	Week 1	-2.00 ± 2.12	4	-3.00 ± 2.74	4	0.180	0.109	0.686
	Week 2	-0.67 ± 3.30	3	-0.80 ± 1.17	5	0.655	0.194	0.786
	Week 3	-1.67 ± 4.64	3	-5.25 ± 3.11	4	0.655	0.109	0.629
	Week 4	-2.33 ± 3.30	3	-0.50 ± 0.87	4	0.317	0.317	0.857
	Week 5	-1.25 ± 2.28	4	-1.67 ± 1.25	3	0.414	0.180	0.629
	Week 6	-2.67 ± 3.09	3	-2.25 ± 1.92	4	0.180	0.109	1.000
	Week 7	1.33 ± 3.30	3	-3.00 ± 2.55	4	0.593	0.109	0.229
	Week 8	-0.50 ± 3.20	4	-2.00 ± 2.12	4	0.593	0.180	0.686
	Week 9	1.67 ± 2.49	3	-0.50 ± 1.50	4	0.414	0.577	0.400
	Week 10	-1.25 ± 2.28	4	-0.25 ± 1.79	4	0.414	0.655	0.686
	Week 11	1.00 ± 3.27	3	-1.80 ± 1.72	5	0.593	0.066	0.393
	Week 12	4.00 ± 4.00	2	-1.50 ± 2.18	4	0.317	0.257	0.267
	Week 13	0.50 ± 0.50	2	-2.75 ± 1.79	4	0.317	0.066	0.133
	Week 14	-3.50 ± 1.50	2	-1.50 ± 2.69	4	0.180	0.357	0.533
	Week 15	-1.50 ± 1.50	2	-1.00 ± 1.41	3	0.317	0.317	0.800
	Week 16	-0.50 ± 3.35	4	-1.75 ± 0.83	4	0.715	0.066	0.686

Discussion

The study population consisted of 61 patients initially but was eventually only 10 patients were included in the analysis, which was presumed to have significantly affected the results. The causes of the remarkably high number of subjects excluded from the analysis set were considered to be the shape of the test food, the high amount of intake, and the high number of survey items. It was also considered that the study subjects were students of the exercise faculty, and that the act of violating the protocol, such as exchanging test foods among the subjects, was easily performed.

1) "Muscle mass"

There was no increase from baseline in the placebo group throughout the 16-week period, whereas the BP group showed a significant increase in the BP group compared with the placebo group at weeks 4 and 8. This suggests that bee pollen may be effective in increasing muscle mass. Subjects consumed protein routinely, and it was considered that components such as proteins contained in bee pollen might have produced additive or synergistic effects.

2) Training

No effects of bee pollen were seen for bench press, squat, clean, and deadlift.

3) Stress Check

Note in the 5) VAS survey.

4) " GO/NO GO"

From the results available to the fourth week, bee pollen was not considered to affect judgment.

5) VAS study

Graphs of 'degree of general pain such as myalgia and arthralgia' and 'physical stress' consistently showed the same trend. From this fact, it was supposed that the subject experienced pain such as muscle pain as a physical stress.

There was no difference between the BP group and the placebo group in the "degree of general pain such as myalgia and arthralgia," but the BP group showed a consistently lower level than the placebo group in the "physical stress" group and a significant improvement at week 4. Since the subjects performed weight training until the fourth week, bee pollen was considered to have relieved physical stress such as fatigue caused by overuse of muscles with weight training.

In each item of "stress check" and "mental stress" there was no significant difference in the comparison between groups, but both items consistently showed improvement tendency in the BP group rather than the placebo group. The ccvTP measured by stress checking was calculated from autonomic balance and pulse, and ccvTP and mental stress were correlated. It was indicated that bee pollen had the role of alleviating the mental stress from this result.

"Willingness, vigor, and degree of willingness to do" consistently showed a tendency for the BP group to be higher than the placebo group. Therefore, it seemed to be able to expect that the willingness significantly increased by extending and observing the ingestion period of bee pollen.

In addition, there was a part in which the mean value fluctuated, but the number of subjects included in the analysis was small, so it was considered that the responses of each subject had a major influence on the results.

6) Questionnaire survey

Note in the 5) VAS survey.

Conclusion

Bee pollen is effective in reducing physical stress. The increase of muscle quantity and relief of mental stress can be expected by long-term intake of bee pollen; however, there was eventually a marked reduction in the number of individuals included in the data analysis. Therefore, it is necessary to test again after taking measures to prevent the reduction of the target population.

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Conflict of interest declaration

In conducting this study, Api Co., Ltd. provided the test products.

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