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Research Note

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Efficacy of immune-strengthening functional drinks in top-level athletes: a questionnaire survey-based research

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[Purpose] Functional beverages are intended to support those who want to maintain optimal physical condition and improve their quality of life through the enhancement of heart health, immunity, and digestion. The purpose of this study was to investigate the performance of top-level athletes consuming immune-strengthening conditioning nutritional drinks.

[Methods] A total of 107 top-level athletes (baseball (56 players), pro volleyball (17), athletics (16), cycling (8), golf (6), and fencing (6)) participated in the experiment. They consumed an immune-enhancing functional beverage once a day for 8 weeks and responded to a survey before, during, and after drinking the beverage.

[Results] Three total aspect-based subfactors were drawn from 24 questions in the factor analysis: physical, satisfaction with mental stability, and activity in performance. The physical, mental stability and performance changes of athletes significantly increased in period 2 (4 weeks after intake) and period 3 (after 8 weeks of intake).

[Conclusion] We evaluated the efficacy of a new conditioned beverage containing *Lactobacillus* B240 and protein in improving the performance and physiological utility of top athletes. This functional drink may gain popularity among those seeking health benefits and improved exercise performance.

[Key words] functional drink, immunity, *Lactobacillus* B240, athlete, sports drink, survey

INTRODUCTION

Immune function is the ability of the body to defend against external antigens.[1] This defense system has been recognized as an important factor in maintaining homeostasis.[2] Regarding the relationship between exercise performance and immune function, although immune function can be improved by performing regular exercise with an appropriately configured exercise program, excessive exercise intensity and amount of exercise are likely to lower immune function.[3]

In particular, top-level athletes frequently over-train to achieve their highest level of performance, and for this reason, each athlete's biological stress is at a high level.[4] This weakens the immunity of top-level athletes, increasing the likelihood of respiratory and endocrine diseases and injuries.[5] In other words, improving physical performance without weakening the immune system is emphasized as a factor that influences overall well-being. Many athletes are likely to experience difficulty in proper maintenance of body homeostasis, including immune function, due to excessive training. A detailed consideration of the body's defense mechanisms related to stress, with regard to immune function, is required.[6] It is necessary to consider athletes' physical and psychological state and performance, along with their level of immunity, in order to manage their physical condition, including that during excessive training.

Functional beverages are generally used to provide health benefits and/or performance improvement. Examples of functional beverages include sports drinks, energy drinks, ion drinks, amino acids, vitamins, minerals, or fruit or vegetable drinks.[7] These functional beverages are gaining popularity with those seeking certain health and performance benefits, particularly among athletes.[8] Such beverages aim to contribute to hydration, maintaining fluid levels, and supporting replenishment of energy in recovery. In addition, these functional beverages are intended to support everyone who wants to maintain optimal physical conditions and improve their performance.[9]

Recently, we reported functional beverages of Lactocacillus pentosus strain b240 (B240) with protein. This novel conditioning drink is a func-

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tional beverage incorporating lactic acid bacteria B240 to strengthen immunity; specifically, it may benefit those with weakened immunity due to extensive athletic training.[10] A jelly type drink containing two billion B240 is combined with whey protein, an essential amino acid blend containing branched-chain amino acids(BCAAs), arginine, and citric acid; this mixture was created to s strengthen immunity in those maintaining top physical condition.[11]

In this study, this new conditioned beverage was evaluated for its practical application in performance through a questionnaire survey of top athletes on performance improvement and physiological efficacy.

METHODS

Subjects

This study was conducted with 107 male and female top-level athletes in six sports (baseball, volleyball, field and track athletes, cycling, golf, fencing), belonging to eight teams. All participants were provided information on the study's purpose and procedures, and then submitted written consent. They were asked to maintain their current lifestyle during the 8-week intervention period. An immune-enhancing functional beverage was ingested once per day. The nutritional facts of the beverages are shown in Table 1. The survey was conducted three times in total, before the intake of beverages, after 4 weeks, and after the 8-week end of intake.

Table 1. Nutrition facts of functional drink.

Nutrition Facts			
			Per pouch (100 g)
Lactic acid Bacteria B240		2 billion	
Energy	90 kcal	Amino acid	2,500 mg
Protein	10 g	Valine	500
Fat	0 g	Leucine	1,000
Carbohydrates	13 g	Isoleucine	500
Salt equivalent	0.11 g	Arginine	500
Vitamin B6	5 mg	Citric acid	1, 250 mg
Vitamin D	10 μg		

Study contents and research tool

The research subjects were selected through primary data collection to find sports and teams suitable for the research plan. The relevant institution was pre-selected as a team with affiliated athletics, player management facilities, and research. After we provided a detailed explanation of the purpose, use of research data, reporting of research results, and an experimental plan, the institutions that allowed research cooperation were selected. After we planned to visit the selected team and explain the survey method, survey tool, and time required, participation was encouraged.

In addition, before starting the questionnaire and interview, athletes belonging to the institution also visited the training site of the team that was accepted as the research subject through pre-request, and we explained the purpose of the study, the nature of the questionnaire, and the significance of responses in detail. We surveyed information regarding subfactors of quality of physical action, satisfaction with mental stability, and activity in performance in athletes by sport. In the form of a group interview survey method, a questionnaire was prepared using the self-administration method for athletes who wished to participate according to their personal intentions.

Survey methods

In the study, the target organization was contacted in advance to plan the visit in order to check athletes' health management status after consumption of beverages for each event. Then, a questionnaire delivered through a direct visit to the facility was completed. The questions were set by referring to the quality of physical action, satisfaction with mental stability, activity in performance based on the questionnaire, and the players on the use of conditioning management status.[12] In order to determine satisfaction among the subjects, the terms and health management method were additionally constructed and revised using the questionnaire.

Statistical analysis

Statistical analyses were performed using SPSS 24.0 (IBM Corporation, Chicago, IL, USA). Characteristics of the subjects and results were summarized using descriptive statistics, and between-group differences were assessed using one-way analysis of variance followed by Fisher's PLSD *post hoc* test. Data are expressed as mean ± SEM, and statistical significance was set at $P < 0.05$.

RESULTS

Participant information analysis

In order to obtain a total of 107 top-level athletes who understood the general information in the experiment, the following were obtained from the frequency analysis of the athletes' events: gender, age distribution, and athletic history through classification using questionnaire items. The number of sports and participation in the experiment included 56 players (52.3%) from two pro baseball teams, 17 players (15.9%) from pro volleyball, 16 players (15.0%) from athletics, eight players (7.5%) from cycling, six players (5.6%) from golf, and four players (3.7%) from fencing. The gender composition was 82 males (76.6%) and 25 females (23.4%). The age distribution was 16-20 years in 7 players (6.5%), 21-25 years old in 33 players (30.8%), 26-30 years in 25 players (23.4%), 31-35 years old in 31 players (29.0%), and 36-40 years old in 11 players (10.3%). Sports experience was surveyed and found to include one player with 1-5 years of experience (0.9%), 18 players with 6-10 years (16.8%), 32 players with 11-15 years (29.9%), 39 players with 16-20 years (36.4%), 15 players with 21-25 years (14.0%), and 2 players with 26-30 years (1.9%) (Table 2).

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Survey analysis

There were three subfactors of total-aspect action: physical, satisfaction with mental stability, and activity in performance as assessed by 24 questions from the factor analysis. To determine the physical aspect changes before, during, and after the intake of functional beverages, the overall scores were averaged and analyzed using a Likert 5-point scale. There was a statistically significant difference between period 1 (before intake) and period 2 (4 weeks after intake), period 3 (after 8 weeks of intake) ($p < .05$) (Figure 1-A). Similarly, the mental stability and performance changes of athletes significantly increased between periods 1 and 2, 3 ($p < .05$) (Figure 1-B, C).

Table 2. Subject information for 107 top-level athletes participating in the experiment.

Variable	Number(n)	Percentage(%)
Athletes' events		
Baseball	56	52.3
Volleyball	17	15.9
Athletes	16	15.0
Cycling	8	7.5
Golf	6	5.6
Fencing	4	3.7
Gender		
Male	82	76.6
Female	25	23.4
Age distribution (years)		
16-20	7	6.5
21-25	33	30.8
26-30	25	23.4
31-35	31	29.0
36-40	11	10.3
Athletic history (years)		
1-5	1	0.9
6-10	18	16.8
11-15	32	29.9
16-20	39	36.4
21-25	15	14.0
26-30	2	1.9

DISCUSSION

This study was conducted to determine whether immune-enhancing functional beverages affect subfactors of physical-aspect behavior in terms of quality, satisfaction with mental stability, and activity in performance using 24 questions from a factor analysis. A total of 107 top-level athletes in six sports were assessed before the intake of beverages, after a 4-week intake of beverages, and after an 8-week intake of beverages. We demonstrated that there was a positive effect on the physical aspect, mental stability, and athletes' performance for at least 4 weeks of beverage consumption. This is related to the effect of a novel conditioned beverage using *Lactobacillus* B240 on the improvement of health and changes in the subject's sports performance.

Most of the athletes who participated in the experiment were active as professional players in six sports games (baseball, volleyball, track and field athletes, cycling, golf, and fencing) belonging to eight teams. Sports were selected to represent all athletes, including team events, individual events, and ball games. In terms of gender, the overall ratio of men was high. All baseball and track and field players were male, and all volleyball athletes were female. Many players had advanced age and athletic experience; about 40% of players were 30 years or older, and those with more than 10 years of experience accounted for more than 80% of the participants.

Professional athletes routinely perform a considerable amount of training. If the body cannot adapt to these overloads, this causes significant stress. Such stress has a negative effect on the body's immune system, which in turn leads to injury or negative effects on physical condition, which ultimately leads to a decrease in exercise performance.[13] In general, continuous exercise at an intensity over the lactate threshold causes a stress response indicated by increased

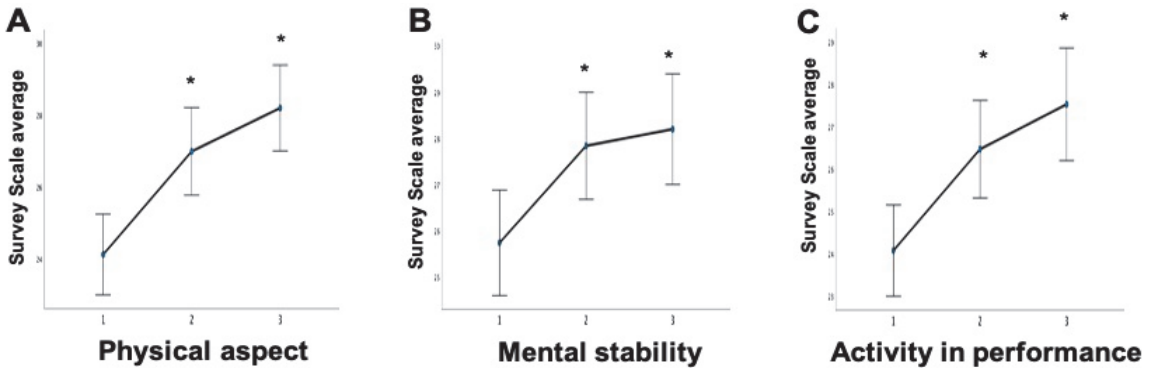

Figure 1. Survey analysis. A. Quality of physical-aspect action with a quality, B. Satisfaction with mental stability C. Activity in performance from 24 questions, analyzed using a Likert 5-point scale.

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plasma ACTH and corticosterone levels in an intensity-dependent manner; the higher the intensity of exercise, the greater the stress response.[14] The exercise-associated stress level or pattern may be an underlying modulating factor for differential effects on body systems. Thus, we measured physical and mental well-being as well as performance in top-level athletes.

In this questionnaire, in the case of period 2 (after 4 weeks) and period 3 (after 8 weeks), statistically significant increases occurred in three subfactors: physical-aspect action quality, satisfaction with mental stability, and activity in performance items. These results could be interpreted as showing the effect of the functional beverage after 4 weeks. In the case of functional foods, it is generally accepted that response adaptations occur, and changes in the body appear when such foods consumed for a certain period of time or longer.[15] In the case of this experiment, effects appeared after the functional beverage had been consumed for at least 4 weeks.

It is generally accepted that conditioning beverages are used widely. The lactic acid bacterium B240 has been shown to reinforce immune function, with the intake of *Lactobacillus* resulting in increased blood T-helper and natural killer (NK) cell counts, as well as enhancement of NK cell activity in elderly adults.[16] We anticipated that high protein content in the beverage would help improve exercise performance, similar to other protein supplements. The present study was planned and conducted to show the usefulness of immune-potentiation beverages containing B240.

Previously, oral administration of B240 in mice resulted in increased synthesis of immunoglobulin A (IgA) from mucosal tissue and increased serum IgG level.[17] Consumption of B240 raises the secretion of salivary IgA in healthy adults and the elderly.[18] Antigen-presenting cells, activated by *Lactobacillus*, may activate Th cells and arouse antibody-producing cells facilitated by cytokine.[19,20] It is known that IgA is produced by plasma cells, which are mature IgA-producing B cells produced in the salivary gland. Antigen-presenting cells, activated by *Lactobacillus*, can activate Th cells and stimulate antibody-producing cells, mediated by cytokines such as IL-6. In this way, B240 ingestion improves immune function. Materials from these previous studies were combined with other ingredients to support suitable physical conditions in novel products, based on the new concept of immune-strengthening drinks.

Although B240 helps balance electrolyte concentrations to support the health and well-being of the subject while maintaining optimum physical condition, we did not find the mechanism of immune system regulation and/or placebo control by *Lactobacillus*. The mechanism of immune system regulation by lactobacilli involves many unresolved questions. Studies have revealed that the effects of B240 intake on IgA secretion may play a critical role in immune function. In the present study, enhanced immune function was associated with a change in physical fitness and performance. It would thus be interesting to address whether functional beverages also produce stronger immunity or lead to increased robustness of other organ systems in future studies.

Overall, this study is the first to evaluate the efficacy of the new conditioned functional drink, which we found to be immune-strengthening, as well as increasing the physical action, mental stability, and athletes' performance as measured by a questionnaire survey. Convenience and health were identified as important factors in user decision-making for beverages. Therefore, this functional drink may gain popularity among those seeking health benefits and the increased exercise performance of athletes. In addition, these functional beverages are intended to support everyone who wants to maintain optimal physical conditions and improve their quality of life.

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