

## *Saengmaeg-san* as an ergogenic aid: improving exercise performance

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**Abstract** : Sports drinks help optimize and improve performance by delaying and eliminating the buildup of fatigue-causing substances in the body during exercise. *Saengmaeg-san* is a nature-friendly traditional beverage that has no side effects on the human body and can quench thirst. However, studies on the relationship between exercise ability and *Saengmaeg-san* are insufficient. The purpose of this study was to prescribe *Saengmaeg-san* during the summer training period of 4 weeks and to analyze the effect on body composition and exercise performance. Seventeen male participants were divided into 3 groups (*Saengmaeg-san* acid intake group [ $n=9$ ], placebo group [ $n=8$ ]), and body composition (height, weight, muscle mass, fat mass, BMI) and conducted exercise performance (total exercise time and HRmax). In our study, *Saengmaeg-san* intake had a positive effect on exercise performance, such as decreased body fat percentage, increased exercise time, and decreased HRmax. Therefore, *Saengmaeg-san* showed the potential as a sports drink. In the future, additional studies on fatigue-related substances, immune function-markers, and blood lipids are needed in order to clearly explain the change in exercise performance due to consumption of *Saengmaeg-san*.

**Keywords** : *Saengmaeg-san*, Ergogenic aids, Body composition, Exercise performance, Tennis player

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## 1. INTRODUCTION

Studies on sports drinks are being actively conducted, as the intake of nutritional supplements is considered crucial for improving exercise performance as well as scientific training methods. Sports drinks help optimize and improve performance by delaying the accumulation of and removing fatigue-inducing substances from the body during exercise.

Sports drinks can be easily consumed before and during exercise, and are available in different types/varieties. Several studies are being conducted to develop sports drinks tailored to the taste of Koreans. A study by Kwak, Yook, and Ha[1] reported that consumption of foods derived from natural sources had a positive effect on body composition. Among the previous studies related to exercise, Gaffney et al.[2] found that consumption of herbal beverages rapidly resynthesized creatine phosphate, an energy source consumed during exercise, and the newly created creatine phosphate increased the exchange rate of adenosine triphosphate, aiding in the removal of fatigue-causing substances in the body, thereby building long-term endurance exercise/training[3]. The authors also mentioned that herbal beverages are rapidly absorbed by the body and stimulate the central nervous system to increase the production of corticosteroids, thereby promoting energy metabolism, and subsequently improving exercise performance[3]. The authors stressed that sports drinks act as a fuel for energy production and replenishment in muscles, and promote the resynthesis of glycogen depleted by exercise. This enables the individual to exercise for a longer time and contributes to replenishment of physical strength[4].

Among them, *Saengmaeg-san* is a traditional nature-friendly drink made of ginseng, lilyturf roots, and schisandra berries that does not cause side effects in the human body and can quench thirst[5]. *Saengmaeg-san* is known to rejuvenate the lungs, replenish depleted lung

fluid while cooling the heart and lungs, and collect sagging lungs[5]. Previous studies have reported on the relationship between ginseng, one of the ingredients of *Saengmaeg-san*, and exercise performance[6,7]; development of lilyturf root drinks and verification of their effect on exercise performance[8,9]; the efficacy of schisandra berries; and body composition and physical fitness[10,11]. There has been steady progress in studies on ginseng, lilyturf roots, and schisandra berries; however, studies on the relationship between exercise capacity and *Saengmaeg-san* are insufficient. In this study, considering the advantages of the individual substances, as stated previously, the authors hypothesized that their synergistic effects in *Saengmaeg-san* would result in superior outcomes. Therefore, the aim of this study was to prescribe *Saengmaeg-san* to college tennis players during the 4 weeks of summer training and analyze its effects on body composition and exercise performance.

## 2. METHODS

### 2.1. Participants

Twenty male tennis players who were enrolled in P University were initially selected, out of which 17 players who took *Saengmaeg-san* and participated in the training program for 4 weeks were selected as final participants. The purpose of the study was explained to all participants, who then voluntarily expressed their intention to participate, and subsequently consented in writing. All participants were examined and interviewed by doctors and were tested to confirm the absence of neurological or musculoskeletal diseases. The participants were restricted from consuming nutritional supplements or drugs that could affect the outcomes of the study 1 month prior to commencement. During the study period, all participants were restricted from consuming dietary supplements other than the provided

*Saengmaeg-san* extract and placebo, and were controlled to avoid additional exercise.

## 2.2. Study design

This double-blind study was conducted on college tennis players to verify the effectiveness of *Saengmaeg-san*. The study process was divided into pre-test, 4-week experimental session, and post-test stages. Twenty participants were initially included, ten each in the *Saengmaeg-san* intake and placebo groups. However, two participants were eliminated during the experiment due to injury or absence, resulting in 17 participants (*Saengmaeg-san* intake group [ $n=9$ ], placebo group [ $n=8$ ]). Changes in body composition (height, weight, muscle mass, body fat mass, and BMI) and exercise performance (total exercise time and HRmax) were analyzed immediately before and immediately after the 4-week exercise program. For successful implementation of the study, the researchers monitored the training programs as well as lifestyle-related parameters of the participants, namely eating habits, additional exercise, and medical treatments.

## 2.3. Training program

The POLAR (Polar RS400sd, APAC, 90026360, USA) heart rate monitor watch was used to measure the changes in heart rate in real time. The program consisted of 10 minutes each of warm-up and clean-up exercises, and 60–70 minutes of the main exercise with an intensity of 70–90% Heart Rate Reserve (HRR) and Rating of Perceived Exertion (RPE) 15–17, 5 times a week for 4 weeks. Basic skill practice, e.g., running strokes, volley and smash, and practice competition (1 set) were conducted as main exercise.

## 2.4. *Saengmaeg-san* sampling and intake

*Saengmaeg-san* was formulated in the same way as described in the study by Lee[12], using 30 g of ingredients in the ratio of

ginseng (7.50 g), lilyturf roots (15 g), and schisandra berries (7.50 g). The ingredients were added into the herbal medicine extractor along with 1,500 ml of water, and were heated for 3 hours at a pressure of 0.7 kg/cm<sup>2</sup> at 100°C to produce the extract.

All participants had the same breakfast before the start of the experiment, and both groups received the drinks in the same small plastic bag according to the double-blind test design. The test group received *Saengmaeg-san* and the placebo group received 100% pure water. The intake method was based on that described in previous studies on herbal beverages. All participants ingested 110 ml of the beverage at each of the following time points: 20 minutes before the start of the exercise, immediately before the exercise, when the main exercise exceeded 30 minutes, after the end of the main exercise, and immediately after the end of the exercise program. The same quantity of the beverages was consumed after breakfast and dinner; therefore, a total of 770 ml per day (110 ml, seven times a day) was consumed for 4 weeks.

## 2.5. Body composition

Body composition measurement was performed using X-scan plus II (Jawon Medical, Korea) at the same time (8:00 a.m) before and after. The participants wore simple clothing that was devoid of any metal components and maintained an empty stomach for accurate measurement.

## 2.6. Exercise performance

Exercise performance was measured using the Schiller CS-200 system (Ergo-Spiro, Schiller AG, Switzerland) with an incremental load exercise method. Based on the Bruce protocol, wherein the speed is increased by 0.8 mph and slope by 2% every 3 minutes from the initial speed of 1.7 mph and slope of 10%, the total exercise time (min) and HRmax (beats/min) after reaching all-out were measured[13].

## 2.7. Statistical analysis

The required number of participants was calculated using the G\*Power 3.1 sample counting program (Kiel University, Kiel, Germany). The results gave a significance level of 0.05, 40% power, and an effect size of 0.25, the default level in the repeated measures ANOVA [14]. The data were analyzed using SPSS ver. 21.0 (IBM Corp., Chicago, IL, USA) to calculate the mean (M) and standard deviation (SD) of the measurement items; repeated measures ANOVA was performed to determine the differences in body composition and exercise performance variables before and after the intake of the Saengmaeg-san extract, followed by Bonferroni's multiple comparison tests for post-hoc analysis. Differences were considered statistically significant at  $p$  values  $< 0.05$ . Effect size (Cohen's  $d$ ) was used to determine the average change between the data before and after the experiment. We used a

standard interpretation of the effect size. ( $d$ :  $|0.20| \leq \text{small} < |0.50| < \text{medium} < |0.80| \leq \text{large}$ ) [15].

## 3. RESULTS AND DISCUSSION

The purpose of the present study was to evaluate the effect of *Saengmaeg-san* intake on changes in body composition and exercise performance during the 4 weeks of summer training in college tennis players. The authors hypothesized that participants in the group consuming *Saengmaeg-san* would experience a positive effect on body composition and exercise performance compared to those in the placebo group. Consequently, significant changes were detected among participants in the *Saengmaeg-san* intake group: a decrease in body fat percentage, an increase in exercise time, and a decrease in maximum heart rate.

Table 1. Change of body composition during summer season training before and after *Saengmaeg-san* supplementation.

Variables	Group	Pre-test	Post-test	Effect size Cohen's $d$	Interaction	Main effect
		Mean $\pm$ SD	Mean $\pm$ SD			
Height (cm)	<i>Saengmaeg-san</i>	177.30 $\pm$ 4.02	177.01 $\pm$ 4.07	-0.07	$P=0.690$	T: $P=0.270$
	Placebo	175.04 $\pm$ 3.69	174.90 $\pm$ 3.97	-0.04		G: $P=0.270$
Body Weight (kg)	<i>Saengmaeg-san</i>	69.74 $\pm$ 7.26	69.28 $\pm$ 7.07	-0.06	$P=0.994$	T: $P=0.093$
	Placebo	68.65 $\pm$ 5.62	68.19 $\pm$ 5.67	-0.08		G: $P=0.733$
% Body fat (%)	<i>Saengmaeg-san</i>	17.17 $\pm$ 5.26	15.88 $\pm$ 5.92**	-0.25	$P=0.621$	T: $P=0.001^{++}$
	Placebo	18.21 $\pm$ 4.22	17.21 $\pm$ 4.36*	-0.24		G: $P=0.631$
Muscle mass (kg)	<i>Saengmaeg-san</i>	53.41 $\pm$ 2.63	53.90 $\pm$ 2.30	0.19	$P=0.685$	T: $P=0.058$
	Placebo	52.00 $\pm$ 2.54	52.33 $\pm$ 2.98	0.13		G: $P=0.253$
BMI (kg/m <sup>2</sup> )	<i>Saengmaeg-san</i>	22.20 $\pm$ 2.28	22.11 $\pm$ 2.27	-0.04	$P=0.949$	T: $P=0.457$
	Placebo	22.39 $\pm$ 1.50	22.31 $\pm$ 1.57	-0.05		T: $P=0.841$

Summary of repeated measures two-way ANOVA and Effect Sizes analysis for body composition data.

Note: BMI=Body Mass Index, T=Time, G=Group. Values are mean  $\pm$  Standard Deviation (SD).

\* $P < 0.05$ , \*\* $P < 0.01$ , ++ $P < 0.001$ . Effect size range:  $|0.20| \leq \text{small} < |0.50|$ ,  $|0.50| < \text{medium} < |0.80|$ ,  $|0.80| \leq \text{large}$ .

The changes in body composition following *Saengmaeg-san* intake were as follows. No significant difference was detected following *Saengmaeg-san* intake in the height, weight, muscle mass, and BMI of the participants. Furthermore, there was no interaction effect based on body fat percentage; however, participants in both groups showed significant decrease in the main effect between periods ( $P < 0.01$ ): participants in the *Saengmaeg-san* group from  $17.17 \pm 5.26$  to  $15.88 \pm 5.92$ , and those in the placebo group from  $18.21 \pm 4.22$  to  $17.21 \pm 4.36$ . Post-test analysis to determine the difference between the groups of time periods revealed that participants in the *Saengmaeg-san* group ( $P < 0.01$ ) showed a higher decrease in body fat percentage than those in the placebo group ( $P < 0.05$ ). Based on these results, it may be considered that *Saengmaeg-san* has a positive effect on body fat reduction by increasing the efficiency of energy consumption. In addition, the vitamins and various mineral components in *Saengmaeg-san* affect physiological metabolism in the body, thereby reducing body fat percentage. Although playing tennis for 4 weeks did not help increase muscle mass because tennis is close to aerobic exercise, it had a positive effect on the reduction of body

fat percentage.

Results of the present study were in accordance with those of previous studies that did not observe a positive effect on body composition. Kim[16] reported that there was no significant change in body composition or positive effects after consumption of red ginseng, a constituent of *Saengmaeg-san*, and schisandra berries for 12 weeks, respectively [10].

In addition, our results were similar to those of other studies, which reported that herbal prescriptions did not show any change in the body composition of athletes[17]. However, the results were marginally different from those of certain studies, which reported positive changes. One study reported that ingesting the extracts of nature-friendly foods had a positive effect on body composition[1]. Similarly, another study demonstrated that aerobic exercise and intake of red ginseng had a positive effect on body composition[18]. Likewise, yet another study reported significant changes in body weight, body fat percentage, and BMI after ingestion of *Saengmaeg-san*[19]. Finally, Kwon and Cho[3] reported that participants in the *Saengmaeg-san* intake group showed a decrease in the body fat percentage and BMI over time.

Table 2. Change of Exercise performance during summer season training before and after *Saengmaeg-san* supplementation

Variables	Group	Pre-test	Post-test	Effect size Cohen's <i>d</i>	Interaction	Main effect
		Mean $\pm$ SD	Mean $\pm$ SD			
Total Exercise Time (min)	<i>Saengmaeg-san</i>	13.53 $\pm$ 0.80	14.98 $\pm$ 0.98***	1.81	$P=0.020^\dagger$	T: $P=0.002^{\dagger\dagger}$
	Placebo	12.19 $\pm$ 1.19	12.46 $\pm$ 1.06	0.23		G: $P=0.000^{\dagger\dagger\dagger}$
HRmax (beats/min)	<i>Saengmaeg-san</i>	196.89 $\pm$ 6.92	185.67 $\pm$ 10.86**	-1.62	$P=0.368$	T: $P=0.001^{\dagger\dagger}$
	Placebo	193.88 $\pm$ 6.64	186.75 $\pm$ 9.50*	-1.07		G: $P=0.792$

Summary of repeated measures two-way ANOVA and Effect Sizes analysis for body composition data.

Note: BMI=Body Mass Index, T=Time, G=Group. Values are mean  $\pm$  Standard Deviation (SD).

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ ,  $^\dagger P < 0.05$ ,  $^{\dagger\dagger} P < 0.01$ ,  $^{\dagger\dagger\dagger} P < 0.001$ .

Effect size range:  $1.201 \leq \text{small} < 1.501$ ,  $1.501 < \text{medium} < 1.801$ ,  $1.801 \leq \text{large}$ .

Among the factors of exercise performance ability, the changes in exercise time and maximum heart rate after ingestion of *Saengmaeg-san* were as follows. First, the exercise time increased from  $13.53 \pm 0.80$  to  $14.98 \pm 0.98$  among participants in the *Saengmaeg-san* group, and  $12.19 \pm 1.19$  to  $12.46 \pm 1.06$  among those in the placebo group ( $P < 0.001$ ), showing an interaction effect ( $P < 0.05$ ) and a significant difference in the main effects based on time periods ( $P < 0.01$ ) and groups ( $P < 0.001$ ). Post-test analysis conducted to confirm the change in each group between periods confirmed that exercise time increased significantly among participants in the *Saengmaeg-san* group ( $P < 0.001$ ). Maximum heart rate decreased from  $196.89 \pm 6.92$  to  $185.67 \pm 10.86$  in participants in the *Saengmaeg-san* group and from  $193.88 \pm 6.64$  to  $186.75 \pm 9.50$  in those in the placebo group. No interaction effect was observed; however, a significant difference was noted in the time-period main effect test ( $P < 0.01$ ). Post-mortem verification conducted to confirm the difference between groups revealed that participants in the *Saengmaeg-san* ( $P < 0.01$ ) and the placebo ( $P < 0.05$ ) groups showed significant differences, and those in the *Saengmaeg-san* group showed a higher decrease in maximal heart rate.

These results corresponded with those of few previous studies as follows. One study in which foods extracted from nature were consumed reported that, the duration of exercise increased among participants in the intake group compared to those in the non-intake group[20]. Similarly, another study showed that the heart rate was lowered at rest after ingestion of *Injin* mugwort extract[21], which helped improve exercise performance. Likewise, one study reported improvement in cardiopulmonary function after consumption of red ginseng[22], while another reported marginal increase in exercise duration after consumption of a drink containing schisandra berries[23]. Other studies that reported similar

results following ingestion of mixtures of different ingredients are as follows. One study reported that ingestion of a mixture of ginseng, saengjihwang, and baekbokryeong for 4 weeks had a positive effect on heart rate[24], while another reported an increase in the maximum exercise time among participants in the intake group compared to those in the control group after consumption of herbal beverages for 4 weeks[17].

Regarding the maximum heart rate, the results of our study were similar to those reported in the following studies. Kim et al. reported a delay in the time to exhaustion following a decrease in the maximum heart rate after consumption of mixed drinks[25, 26]. Another study demonstrated that intake of a mixed drink of lilyturf roots, plum, and acanthopanax senticosus enhanced endurance [27]. Furthermore, a study reported that exercise was sustained for a longer time in the group that consumed red ginseng and peony[28].

Likewise, Barkrie et al.[11] showed that participants in the group that consumed a drink mixed with schisandra berries and plums experienced double effect on enhanced exercise performance. In addition, our study results supported those of the following studies. One study found a decrease in the maximal heart rate and an increase in oxygen intake following ingestion of *Saengmaeg-san*[29]. Another study reported reduced maximal heart rate in canoe athletes following ingestion of *Saengmaeg-san*[30]. In our study, intake of sugar-containing beverages was hypothesized to have supplemented water and electrolytes lost due to sweating, thereby delaying cardiopulmonary function and fatigue. Our results support those reported by Gaffney et al.[2] that intake of herbal beverages rapidly resynthesizes creatine phosphate, an energy source consumed during exercise, which in turn increases the ATP exchange rate, aiding in the removal of fatigue-causing substances within the body. In addition, the herbal drink

*Saengmaeg-san* promotes the resynthesis of glycogen depleted by exercise, contributing to sustenance of exercise for a long time by functioning as a fuel for energy production and replenishment in muscles[4]. *Saengmaeg-san* contains saponin, which appears to replenish depleted body fluids, increase the concentration of hemoglobin in the blood, activate the metabolic activity of muscle mitochondria, thereby positively influencing the factors related to exercise performance. These results are hypothesized to be due to the interaction of the herbal ingredients in *Saengmaeg-san*. Therefore, the present study has demonstrated that consumption of *Saengmaeg-san* has positive effects on body fat percentage, exercise performance ability, maximum heart rate, and exercise time.

#### 4. CONCLUSION

In the present study, the intake of *Saengmaeg-san* resulted in a decrease in body fat percentage, an increase in exercise time, and a decrease in the maximum heart rate, all of which had a positive effect on exercise performance. Therefore, *Saengmaeg-san* showed potential as a sports drink. In the future, additional studies on fatigue-related substances, hormones related to immune function, and blood lipids are needed to clearly explain the changes in exercise performance in accordance with the intake of *Saengmaeg-san*. Furthermore, the authors look forward to a study pertaining to the physiological mechanism by which *Saengmaeg-san* improves exercise performance.

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