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INFLUENCE OF A LUCUMA-BASED CARBOHYDRATE BEVERAGE ON ATHLETES

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ABSTRACT

This study focuses on a carbohydrate-containing beverage with water, 1.5% skim milk powder and lucuma fruit powder (Pouteria Lucuma). The aim is to analyze the influence of the beverage on the sports performance of young men with different levels of motor activity. The analysis of the results was based on the changes in some biometric parameters and the level of motor activity of 8 young men (experimental group; EG) consuming the beverage half an hour before fitness exercises – bodybuilding workouts – within a three-month period of time. The results obtained from the tests were compared to the results shown by the 13 men in the control group (CG) for the same period of time without consuming the beverage. On the basis of the profiles of the respondents from both groups (EG and CG), we analyzed the changes in body composition and motor activity at the beginning and at the end of the three-month period. The results obtained from the comparative analysis revealed that both groups manifested positive changes concerning the level of motor activity as a result of the training program. These positive changes turned out to be more significant in the EG with respect to maximum oxygen intake and plank endurance. We also analyzed the modifications in the correlational dependencies as regards EG parameters, as a result of which we established more significant dependencies at the end of the test period.

The results of the present study show that the consumption of the lucuma-based carbohydrate beverage by the experimental group has a positive effect on the analyzed parameters.

***Key words**: lucuma, endurance, maximum oxygen intake, maximum power, food supplements*

INTRODUCTION

Recent years have witnessed an increasing interest in healthy lifestyle. In order to get all the essential nutrients, people are advised to take in food supplements (FS). A great number of professional and amateur athletes consume food supplements to benefit to a considerable extent from their physical training (Burke, 2015; Maughan, et al., 2011; Sanches-Oliver, et al., 2018). They usually consume vitamins, minerals, antioxidants, energy drinks, proteins, protein bars, shakes rich in carbohydrates, and sometimes amino acids and other ergogenic substances (Maughan, et al., 2007; Braun, et al., 2009). D. Dimitrova subdivides food supplements into FS with guaranteed safety and efficiency, FS with potential efficiency proven theoretically by preliminary research, and FS whose efficiency has been proven theoretically but not in practice (Dimitrova, 2014).

The advantages of consuming food supplements in the course of physical training have been described and studied by many

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scientists. Angelova, et al., (2010) discovered that, during their three-month training, aerobic gymnastics competitors who took in FS (amino acids, micronutrients and L-carnitine) manifested a decrease in fat and water and an increase in muscle mass with no discernible changes in the breathing capacity. A detailed study showed that the consumption of Carboenergy, a product high in carbohydrates, 30 minutes before training resulted in the reduction of body fat and the improvement of the aerobic capacity of the participants in the experiment (Angelova, et al., 2011; Angelova, et al. 2012). Ivy, et al., (2009) talked about the improvement of bikers' performance after the intake of carbohydrate beverages whereas Rica et al, (2019) did not report any improvement in the abilities of amateur runners following energy drink intake.

A greater number of contemporary studies focus on regionally atypical plant species which are high in nutrients and can be incorporated into high-quality food products to fulfill the needs of the human organism (Ghouila, et al., 2017). The literature review attracted our interest to the nourishing natural product called lucuma (*Pouteria Lucuma*) which is a subtropical fruit known as "the gold of the Incas" grown in the mountains of Peru, Chile and Ecuador (Villanueva, 2002; Aguilar, 2015; Caballero, Aguilar, 2017).

Lucuma powder is widely used in the food industry in the preparation of ice cream, sweets, confectionery, juice, yogurt and cream. Because of its sweet taste and the presence of dietary fiber, this powdery product satisfies the appetite for carbohydrates without harming the human organism (Banasiak, 2003; Dini, 2011; Rojo, et al., 2010). Erazo, et al., (1999); Verbeke, (2006); Fuentealba, et al., (2016) pointed out that lucuma powder was rich in phenols, flavonoids and beta-carotene recognized as powerful antioxidants.

Due to its high concentration of biologically active substances, minerals, antioxidants and other nutrients, lucuma is referred to as a superfood because it boosts the immune system and supplies the organism with energy (Mukta, 2017, DGA, 2015-2020).

Scientific research proves the positive effects of taking in food supplements while practicing sports when the food supplements are widely used and recognized by consumers. No data have been discovered concerning research on carbohydrate-containing beverages with lucuma powder in order to ascertain the influence of such beverages on sports skills.

The aim of this study is grounded on the worldwide tendency to substitute natural fruit sources for chemically based food supplements: *analysis of the nutritional value of a lucuma-powder beverage and determination of its influence on the sports performance of students practicing fitness and bodybuilding.*

MATERIALS AND METHODS

We used commercial lucuma powder, which was produced in Peru, purchased in Bulgaria by "Internet café-BG" Ltd, packaged by "Zoya bg Organic Shop" and certified by ABG GmbH BG-BIO-16. Skim milk powder (1.5%) was also used. It was produced in the European Union and packaged by Bioset OOD, BG1618041EO.

The approximate average physicochemical composition of the new mixture was determined according to the analytical methods of the Association of Official Analytical Chemists (AOAC), 2005: AOAC (2005) Determination of Moisture, Ash, Protein and Fat. Official Method of Analysis of the Association of Analytical Chemists, 18th Edition, AOAC, Washington DC.

Carbohydrate content in percentages was calculated as the difference between 100% total mass and the percentage of fat, protein, ash, and moisture content (Ferris, et al., 1995).

In order to produce the lucuma-powder beverage, a number of laboratory tests were conducted to determine the optimal amounts of its components. One of the main objectives was to free the beverage of impurities and other components as far as possible. The homogenization of a mixture of water and lucuma powder made the beverage somewhat unpleasant and insipid. Therefore, its flavor was improved with the addition of skim cow milk powder with fat content of 1.5 %. The recipe for the beverage obtained is the following: 15 g of lucuma powder, 15 g of skim cow milk powder with fat content of 1.5 %, and 200 ml of water. The water used was purified with a filtration system. The substances were measured with "Joycare" electronic scales and mixed in shakers used individually by every student.

The present study was conducted with the voluntary participation of first-year students practicing fitness and bodybuilding for 90 minutes three times a week. The basic training was conducted in a mixed and in an anaerobic regime of energy supply since its parameters were determined with respect to students' individual abilities.

All participants followed an unrestricted diet and no calorie intake was taken into account.

Two test groups were formed:

- an experimental group (EG) consisting of 8 students and
- a control group (CG) with 13 students.

For three months, the students from the EG consumed the lucuma-based carbohydrate beverage 2-3 times a week, 30 minutes before their classes. The aim was to boost their energy resources, improve their sports performance, and enhance positive structural and functional changes in their bodies. During the same period of time, the students from the CG participated in the training without taking in a carbohydrate beverage.

With the help of the "Tanita – RD 953" body composition monitor, which applies cutting-edge technologies for bioelectrical impedance analysis (BIA), we obtained data on the respondents' body composition. On the basis of the age, sex, height, and weight of the participants in the experiment, the monitor provides information on the following parameters:

- Weight (kg);
- BMI - body mass index (kg/m2);
- Body fat (%);
- Muscle mass (kg);
- Muscle quality (%);
- Physique rating (0-10);
- Visceral fat (%);
- Metabolic age (years);
- Body water (%).

To determine the level of motor activity at the beginning and at the end of the test period, the participants were subjected to:

- Beep test – It evaluates the level of maximum oxygen consumption, a significant functional parameter for physical endurance.
- Plank test – It evaluates strength endurance. During the test, all muscle groups are subjected to isometric exercise for the longest period of time possible.
- Barbell bench press – It assesses maximum power via a single lift of maximum weight.

The following parameters were analyzed:

- VO_2max – maximum oxygen intake, (aerobic endurance) (ml/kg/min);
- Endurance plank – strength endurance - plank (seconds);
- Max power – maximum power (kg).

The frequency of lucuma intake was established on the basis of these two parameters:

- N of trainings – number of trainings per week;
- Lucuma intake – number of intakes of the beverage.

The statistical processing of the data was conducted with the IBM SPSS16 program.

The statistical analysis resorted to the following statistical methods: variation, comparative, correlation analyses.

The results obtained have statistical significance, with a probability of $P = 95\%$ and error of $\alpha = 5\%$.

RESULTS AND DISCUSSION

Table 1 shows the results from the physicochemical analysis of the beverage mixture. The mixture is rich in carbohydrates, i.e. 65.5%. Carbohydrates are a major energy source because they provide between 55 and 60% of the daily energy requirements (Gachev, Djarova, 2003; Balch, Balch, 2005; Dimitrova, 2014). Since it is high in carbohydrates, the product could fulfill the greater energy needs of the human organism in the course of physical training, thus sparing the glycogen stored in muscles and liver.

Table 1. *Approximate average physicochemical composition of the ready-made beverage mixture, 100 g.*

Sample	Proteins, %	Carbohydrates, %	Moisture, %	Fat, %	Ash, %
Ready-made beverage mixture	21.5	65.5	8.3	1.5	3.2
Lucuma powder	4	82.2	10.7	1.1	2
Dry milk	32	55	6.1	1.5	5.4

EG and CG respondents' profile at the beginning and at the end of the test period

The average age of the students (male) in the EG was 19.44 years, for a standard deviation of 0.55 years, whereas that of the students in the CG was 19.55 years, for a standard deviation of 1.19 years.

Table 2 presents the modifications of the parameters related to the body composition and motor activity of EG students at the beginning and at the end of the test period. We established changes in the values of the biometric parameters at the end of the period attributable to the combined effect of the beverage intake and the physical training.

The respondents' weight rose by 1.900 kg together with an increase in muscle mass by 1.1375 kg. Body fat was increased by 0.775%, and visceral fat – by 0.538%. This may be due to the time period when the experiments were conducted (October – January) when the higher values of these parameters are acceptable. At the end of the analyzed period, the muscle quality value was also higher (59.25 MQ) for the EG, the increase corresponding to the average value of standard scores. The body water value was decreased by 0.837%, the value remaining in the healthy body range.

More significant changes were identified with respect to the parameters determining the motor activity level following the lucuma-based beverage intake. During the beep test, we discovered an increase in the maximum oxygen intake by +8.800 ml/kg/min. The most significant was the increase during the plank endurance test, by 52.625 seconds. During the barbell bench press exercise, maximum power rose by 4.375 kg.

Table 2. *Descriptive statistics of the EG parameters at the beginning and at the end of the test period (n = 8)*

N	Parameters	Start / Finish	Mean	Std. Deviation	Std. Error Mean	Mean Difference
1	Metabolic Age	Start Finish	12.88 15.00	1.642 3.207	.581 1.134	2.125
2	Weight	Start Finish	75.375 77.275	8.825 10.001	3.120 3.536	+1.900
3	BMI	Start Finish	24.113 24.663	3.586 3.846	1.268 1.360	+.550
4	Body fat	Start Finish	13.812 14.588	4.137 4.162	1.463 1.472	+.775
5	Musc mass	Start Finish	61.450 62.588	6.145 7.077	2.173 2.502	+1.1375
6	Musc quality	Start Finish	57.13 59.25	11.307 10.361	3.997 3.663	+2.125
7	Visceral fat	Start Finish	1.88 2.41	1.246 1.167	.441 .413	+.538
8	Body water	Start Finish	61.31 60.48	2.779 2.244	.983 .793	-.837
9	N of trainings	Start Finish	3.13 3.13	1.246 1.246	.441 .441	.000
10	Lucuma intake	Start Finish	2.38 2.38	.518 .518	.183 .183	.000
11	VO_2max	Start Finish	29.838 38.638	3.778 4.025	1.336 1.423	+8.800
12	Endurance plank	Start Finish	147.50 200.13	40.242 54.520	14.228 19.276	+52.625
13	Max power	Start Finish	75.38 79.75	19.078 20.748	6.745 7.336	+4.375

The modifications in the body composition and motor activity parameters of CG students at the beginning and at the end of the test period are presented in Table 3.

We identified an insignificant increase in metabolic age, by 0.154 years, an increase in weight by 1.115 kg, and a decrease in muscle mass by 0.0846 kg. In the CG, body fat rose by 0.9846%, whereas the increase in visceral fat was insignificant, by 0.115%. Muscle quality rose by 0.3846 MQ. Body water decreased by 1.0231%, the value remaining in the healthy body range. The beep test showed an increase in maximum oxygen intake by +3.2692 ml/kg/min. The plank test manifested a greater increase, by 38.0769 seconds at the end of the exercise as compared to the beginning. During the barbell bench press exercise, maximum power rose by 5.000 kg.

Analysis of the modifications of the parameters of the EG and the CG at the beginning and at the end of the test period

Table 3. *Descriptive statistics of the CG parameters at the beginning and at the end of the test period (n = 13)*

N	Parameters	Start / Finish	Mean	Std. Deviation	Std. Error Mean	Mean Difference
1	Metabolic Age	Start Finish	20.08 19.92	10.782 10.610	2.990 2.943	-.154

2	Weight	Start	78.046	14.6348	4.0590	+1.1154
		Finish	79.162	14.4336	4.0031	
3	BMI	Start	24.446	3.7451	1.0384	+1.1154
		Finish	25.562	4.4237	1.2269	
4	Body Fat	Start	14.562	7.8048	2.1647	+.9846
		Finish	15.546	7.2888	2.0215	
5	Musc Mass	Start	62.823	7.6715	2.1277	-.0846
		Finish	62.738	7.0679	1.9603	
6	Musc quality	Start	61.62	8.026	2.226	+.3846
		Finish	62.00	8.612	2.389	
7	Visceral fat	Start	2.85	2.528	.701	+.1154
		Finish	2.96	2.681	.743	
8	Body water	Start	59.92	5.255	1.457	-1.0231
		Finish	58.89	4.401	1.221	
9	N of trainings	Start	3.54	1.127	.312	.000
		Finish	3.54	1.127	.312	
10	Lucuma intake	Start	.00	.000*	.000	.000
		Finish	.00	.000*	.000	
11	VO_2max	Start	30.192	5.7487	1.5944	+3.2692
		Finish	33.462	6.8561	1.9015	
12	Endurance plank	Start	180.69	81.557	22.620	+38.0769
		Finish	218.77	118.344	32.823	
13	Max power	Start	82.31	21.758	6.034	+5.000
		Finish	87.31	21.565	5.981	

In order to determine whether the differences in the parameter values for EG students at the end of the test period had a statistical significance, we applied the Paired-Samples T-test in SPSS16. The results obtained are presented in Table 4. The results of the Paired-Samples T-test showed that the differences in the mean values at the end of the period, as compared to the beginning of the period, had statistical significance for the following parameters: Metabolic Age, Weight, BMI, VO_2max, Plank endurance and Maximum power.

The difference between Metabolic Age2 -Metabolic Age1 = 2.124. The statistical significance, for a level of significance for t = 2.429 is Sig. t (2-tailed) = .046 < α = .05.

The difference between Weight2 - Weight1 = 1.90. The statistical significance, for a level of significance for t = 3.170 is Sig. t (2-tailed) = .016 < α = .05.

The difference between BMI2 - BMI1 = .55. The statistical significance, for a level of significance for t = 3.317 is Sig. t (2-tailed) = .013 < α = .05.

The difference between VO_2max2 - VO_2max1 = 8.80. The statistical significance, for a level of significance for t = 5.259 is Sig. t (2-tailed) = .001 < α = .05.

The difference between Endurance plank2 - Endurance plank1 = 52.625. The statistical significance, for a level of significance for t = 4.418 is Sig. t (2-tailed) = .003 < α = .05.

The difference between Max power2 - Max power1 = 4.375. The statistical significance, for a level of significance for t = 3.123 is Sig. t (2-tailed) = .017 < α = .05.

As regards the other parameters, the differences in their mean values at the end of the test period, as compared to the beginning of the test period, did not have statistical significance since for each of these parameters the level of significance is Sig. t (2-tailed) > α = .05.

Table 4. *Comparative analysis of the parameter modifications for the EG at the beginning and at the end of the test period*

		Paired Samples Test							
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Metabolic Age2 Metabolic Age1	2.125	2.475	.875	.056	4.194	2.429	7	.046
Pair 2	Weight2 - Weight1	1.9000	1.6954	.5994	.4826	3.3174	3.170	7	.016
Pair 3	BMI2 - BMI1	.5500	.4690	.1658	.1579	.9421	3.317	7	.013
Pair 4	Bodyfat2 - Body fat1	.7750	2.4703	.8734	-1.2902	2.8402	.887	7	.404
Pair 5	Muscle mass2 - Muscle mass1	1.1375	2.3330	.8248	-.8129	3.0879	1.379	7	.210
Pair 6	Muscle quality2 - Muscle quality1	2.1250	7.7540	2.7415	-4.3575	8.6075	.775	7	.464
Pair 7	Physique Raiting2 - Physique Raiting1	.1250	.3536	.1250	-1.706	.4206	1.000	7	.351
Pair 8	Visceral Fat2 - Visceral Fat1	.5375	1.0941	.3868	-3.772	1.4522	1.390	7	.207
Pair 9	Body Water2 - Body Water1	-.8375	1.6106	.5694	-2.1840	.5090	-1.471	7	.185
Pair 10	VO_2max2 - VO_2max1	8.8000	4.7329	1.6733	4.8432	12.7568	5.259	7	.001
Pair 11	Endurance plank2 - Endurance plank1	52.6250	33.6874	11.9103	24.4616	80.7884	4.418	7	.003
Pair 12	Max power2 - Max power1	4.3750	3.9619	1.4007	1.0628	7.6872	3.123	7	.017

In order to test the hypotheses concerning the statistical significance of the differences in the mean values of the parameters for the CG at the end of the test period, as compared to the beginning of the test period, we used the Paired-Samples T-test (Table 5).

The results of the Paired-Samples T-test showed that the differences in the mean values at the end of the period, as compared to the beginning of the period, had statistical significance for the following parameters: Weight, Body fat, Body Water, VO_2max, Plank endurance and Maximum power.

The difference between Weight2 - Weight1= 1.1154. The statistical significance, for a level of significance for t = 3.468 is Sig. t (2-tailed) = .005 < α = .05.

The difference between Body fat2 – Body fat1 = .9846. The statistical significance, for a level of significance for t = 2.602 is Sig. t (2-tailed) = .023 < α = .05.

The difference between Body Water2 – Body Water1 = -1.0231. The statistical significance, for a level of significance for t = -3.035 is Sig. t (2-tailed) = .010 < α = .05.

The difference between VO_2max2 - VO_2max1 = 3.2692. The statistical significance, for a level of significance for t = 2.639 is Sig. t (2-tailed) = .022 < α = .05.

The difference between Endurance plank2 -

Endurance plank1 = 38.0769. It has a statistical significance since the level of significance for $t = 2.475$ is Sig. t (2-tailed) = .029 < $\alpha = .05$.

The difference between Max power2 - Max power1 = 5.00. The statistical significance, for a level of significance for $t = 3.950$ is Sig. t (2-tailed) = .002 < $\alpha = .05$.

As regards the other parameters, the differences in their mean values at the end of the test period, as compared to the beginning of the test period, did not have statistical significance since for each of these parameters the level of significance is Sig. t (2-tailed) > $\alpha = .05$.

Comparative analysis of the modifications of the parameters of the EG and the CG at the beginning and at the end of the test period

Table 5. *Comparative analysis of the parameter modifications for the CG at the beginning and at the end of the test period*

Paired Samples Test										
		Paired Differences								
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Metabolic Age2 Metabolic Age1	.154	1.068	.296	-.492	.799	.519	12	.613
Pair 2	Weight2 - Weight1	1.1154	1.1596	.3216	.4146	1.8161	3.468	12	.005
Pair 3	BMI2 - BMI1	1.1154	2.9311	.8129	-.6559	2.8866	1.372	12	.195
Pair 4	Body fat2 - Body fat1	.9846	1.3643	.3784	-.1602	1.8091	2.602	12	.023
Pair 5	Muscle mass2 - Muscle mass1	-.0846	1.4381	.3989	-.9536	.7844	-.212	12	.836
Pair 6	Muscle quality2 - Muscle quality1	.3846	6.4361	1.7850	-3.5047	4.2739	.215	12	.833
Pair 7	Physique Raiting2 - Physique Raiting1	-.462	1.391	.386	-1.302	.379	-1.196	12	.255
Pair 8	Visceral Fat2 - Visceral Fat1	.1154	.2193	.0608	-.0171	.2479	1.897	12	.082
Pair 9	Body Water2 - Body Water1	-1.0231	1.2153	.3371	-1.7575	-.2887	-3.035	12	.010
Pair 10	VO_2max2 - VO_2max1	3.2692	4.4668	1.2389	.5700	5.9685	2.639	12	.022
Pair 11	Endurance plank2 - Endurance plank1	38.0769	55.4669	15.3837	4.5586	71.5952	2.475	12	.029
Pair 12	Max power2 - Max power1	5.0000	4.5664	1.2659	2.2418	7.7582	3.950	12	.002

For each separate group, we calculated the differences in the mean values of the parameters at the end of the test period, as compared to the beginning of the test period. They characterize the modifications in the parameters attributable to the effects of the lucuma-based carbohydrate beverage and the EG students' training as well as the changes of the parameters for the CG students solely due to the physical training. For instance, concerning weight, the difference is determined as follows: *Weight = Weight2 – Weight1*, where:

- *Weight1* is the average weight of the students in the group at the beginning of the test period;

- *Weight2* is the average weight of the students in the group at the end of the test period;
- *Weight* – is the modification of the average weight of the students in the group.

In a similar fashion, we also calculated the differences in the mean values for all other parameters.

In order to compare the changes in the parameters for both groups, we applied the Independent Samples T-test. This test determines whether there are statistically significant differences in the modifications of the parameters for the two groups. The results are presented in Table 6.

Table 6. *Comparative analysis of the modifications in the parameters in the EG and the CG*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper
Metabolic Age		14.039	.001	2.542	19	.020	1.97115	.77535	.34832	3.59398
Weight	Equal variances assumed	.907	.353	1.264	19	.222	.78462	.62074	-.51461	2.08384
BMI	Equal variances assumed	1.635	.216	-.536	19	.598	-.56538	1.05453	-2.77254	1.64177
Body fat	Equal variances assumed	1.172	.293	-.252	19	.804	-.20962	.83147	-1.94990	1.53067
Muscle mass	Equal variances assumed	1.946	.179	1.495	19	.151	1.22212	.81770	-.48936	2.93359
Muscle quality	Equal variances assumed	.418	.526	.557	19	.584	1.74038	3.12339	-4.79694	8.27771
Physique Raiting	Equal variances assumed	3.904	.063	1.159	19	.261	.58654	.50615	-.47284	1.64592
Visceral Fat	Equal variances assumed	10.414	.004	1.368	19	.187	.42212	.30851	-.22360	1.06783
Body Water	Equal variances assumed	.059	.811	.301	19	.767	.18558	.61752	-1.10691	1.47807
VO2max	Equal variances assumed	.083	.776	2.695	19	.014	5.53077	2.05205	1.23577	9.82577
Endurance plank	Equal variances assumed	1.554	.228	.666	19	.513	14.54808	21.83531	-31.15375	60.24991
Max power	Equal variances assumed	.547	.469	-.320	19	.753	-.62500	1.95565	-4.71823	3.46823

The results from the Independent Samples T-test showed that for both groups there was a statistically significant difference in the modification of the VO_2max parameter. The level of significance of $t = 2.695$ is Sig. t (2-tailed) $= .014 < \alpha = .05$. As regards the other parameters, no statistically significant differences in their modifications were identified. For both groups (EG and CG), we established a statistically significant difference in the modification of the Metabolit_Age parameter. The level of significance of $t = 2.542$ is Sig. t (2-tailed) = $.020 < \alpha = .05$. In this case, the Levene's test showed that the dispersions in the groups differed significantly, as a result of which it was necessary to test the hypothesis additionally with the help of the non-parametric Wilcoxon W test which confirmed the conclusion for Asymp. Sig. (2-tailed) = $.047 < \alpha = .05$.

Determining correlational dependencies between the parameters at the beginning and at the end of the test period

To determine the statistically significant correlational dependencies between the parameters studied, with the help of the SPSS16 statistical package, we produced two correlation matrices for the EG concerning the beginning and the end of the test period. We identified strong correlational dependencies between the parameters characterizing the motor activity level and the other variables, both at the beginning (Table 7) and at the end (Table 8) of the test period.

In Table 7, the correlation matrix illustrates that there were very strong dependencies between:

- weight – and BMI, amount of body water in percentages, muscle mass, visceral fat;
- BMI – and muscle mass, visceral fat and % body water.
- Body Fat – and visceral fat and % body water.

In Table 8, the correlation matrix shows that there were very strong dependencies. We established a very strong, statistically significant, correlation between weight and: muscle mass expressed by ($r = .933$, $P = .001$); BMI ($r = .931$, $P = .001$); visceral fat ($r = .772$, $P = .025$). The loss of body water is attributable to the increase in: weight ($r = -.759$, $P = .029$); BMI ($r = -.894$, $P = .003$); Body Fat ($r = -.869$, $P = .005$). The improvement in Muscle quality2 is logically attributed to a great extent to the improvement of Physique Raiting2 ($r = .845$, $P = .008$).

Table 7. *Correlation matrix for the EG concerning the beginning of the test period*

Correlations												
		Weight1	**BMI1**	**Body fat1**	**Muscle mass1**	**Muscle quality1**	**Physique Raiting1**	**Visceral Fat1**	**Body Water1**	**VO_2 max1**	**Endurance plank1**	**Max power1**
Weight1	R	1	.926**	.498	.894**	.512	.275	.722*	-.802*	.586	-.206	.692
BMI1	R	.926**	1	.683	.722*	.616	.115	.752*	-.937**	.436	-.078	.636
Body fat1	R	.498	.683	1	.063	.237	-.449	.764*	-.834**	-.147	.356	.128
Muscle mass1	R	.894**	.722*	.063	1	.461	.508	.406	-.495	.789*	-.383	.724*
Muscle quality1	R	.512	.616	.237	.461	1	.365	.392	-.673	.168	-.578	.863**
Physique Raiting1	R	.275	.115	-.449	.508	.365	1	.192	.045	.274	-.811*	.410
Visceral Fat1	R	.722*	.752*	.764*	.406	.392	.192	1	-.814*	-.047	-.168	.375
Body Water1	R	-.802*	-.937**	-.834**	-.495	-.673	.045	-.814*	1	-.169	.065	-.598
VO_2 max1	R	.586	.436	-.147	.789*	.168	.274	-.047	-.169	1	-.094	.422
Endurance plank1	R	-.206	-.078	.356	-.383	-.578	-.811*	-.168	.065	-.094	1	-.506
Max power1	R	.692	.636	.128	.724*	.863**	.410	.375	-.598	.422	-.506	1
	N	8	8	8	8	83	8	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 8. *Correlation matrix for the EG concerning the end of the test period*

Correlations		Weight2	BMI2	Body fat2	Muscle mass2	Muscle quality2	Physique Raiting2	Visceral Fat2	Body Water2	VO2max2	Endurance plank2	Max power2
Weight2	R	1	.931**	.463	.933**	.216	.266	.772*	-.759*	-.039	-.212	.769*
BMI2	R	.931**	1	.644	.787*	.193	.125	.877**	-.894**	-.080	.019	.747*
Body fat2	R	.463	.644	1	.115	-.501	-.663	.748*	-.869**	.304	.757*	.079
Muscle mass2	R	.933**	.787*	.115	1	.455	.567	.557	-.501	-.174	-.544	.843**
Muscle quality2	R	.216	.193	-.501	.455	1	.845**	-.050	.047	-.253	-.723*	.675
Physique Raiting2	R	.266	.125	-.663	.567	.845**	1	-.058	.248	-.472	-.941**	.558
Visceral Fat2	R	.772*	.877**	.748*	.557	-.050	-.058	1	-.892**	.111	.237	.397
Body Water2	R	-.759*	-894**	-.869**	-.501	.047	.248	-.892**	1	-.274	-.403	-.474
VO_2max2	R	-.039	-.080	.304	-.174	-.253	-.472	.111	-.274	1	.444	-.329
Endurance plank2	R	-.212	.019	.757*	-.544	-.723*	-.941**	.237	-.403	.444	1	-.496
Max power2	R	.769*	.747*	.079	.843**	.675	.558	.397	-.474	-.329	-.496	1
	N	8	8	8	8	83	8	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

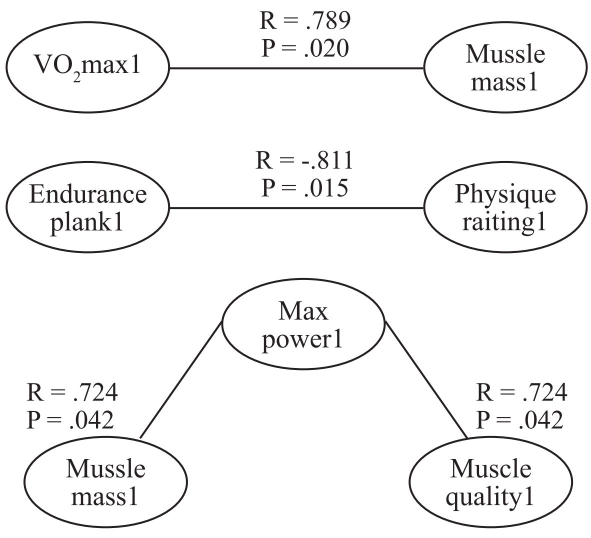

Figure 1. *Statistically significant correlations accounting for the motor activity of the EG at the beginning of the test period*

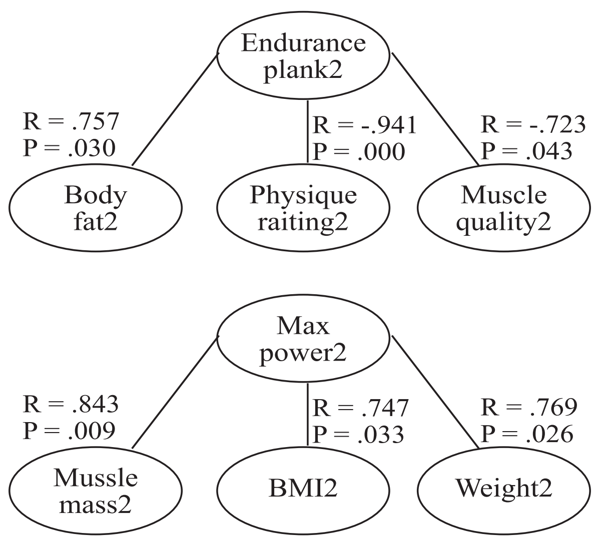

Figure 2. *Statistically significant correlations accounting for the motor activity of the EG at the end of the test period*

Figures 1 and 2 illustrate very strong correlations accounting for the motor activity of the EG at the beginning and at the end of the test period. On the basis of the analysis concerning the end of the test period (Table 2), we identified a strong negative (r = - .723, P = .043 – Muscle quality2) and a very strong correlation (r = - .941, P = .000 – Physique Raiting2) affecting Endurance plank2. The increase in Muscle mass2, Weight2 and BMI2 strongly affect the increase in MaxPower2, as expressed by means of (r = .843, P = .009); (r = .769, P = .026) and (r = .747, P = .033).

CONCLUSIONS

We produced a new carbohydrate beverage containing lucuma powder and determined its approximate physio-chemical composition: 21.5% protein, 65.5% carbohydrate, 8.3% moisture, 1.5% fat and 3.2% ash. Since it is rich in carbohydrates, the lucuma-based beverage can be used in sports training in order to improve the energy resources of the organism, immediately prior to physical exercises.

The results from the analysis of the motor activity of the EG students at the end of the test period, obtained after the consumption of the beverage, manifest positive changes in the level of maximum oxygen intake (VO_2max), plank test endurance and maximum power. The comparative analysis of the modifications in the EG and CG parameters shows that the modifications are more significant for the EG concerning maximum oxygen intake, muscle mass, muscle quality and plank endurance. The correlational dependencies for the EG at the beginning and at the end of the test period manifest that the effects of the carbohydrate beverage and the physical training are combined in order to bring about modifications in body composition leading to significant functional changes.

On the basis of the obtained results and the analyses carried out, we believe that the lucuma-based carbohydrate beverage can be applied in sports training in order to improve the energy resources of the organism, immediately prior to physical exercises.

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REFERENCES

Aguilar, D. S. (2015). Economics. Lucuma as an exotic high-quality fruit imported into Portugal and the UE. A Work Project presented as part of the requirements for the Award of a Master's Degree in Management from the NOVA – *School of Business and Economics*. 1-36.

Angelova, P., Boyadzhiev, N., Ivanova, A., Muletarov, Sp., Basheva. Y. (2010). Antropometrichna I funkcionalna harakteristika na elitni sastezatelki po aerobika v nachaloto I v kraya na podgotvitelniya im period, *Nauchni trudove na Sayuza na uchenite v Bulgaria* – Plovdiv, t. XII, *Nauchna sesiya "Meditsina I dentalna medicina*", str. 38-41. // Ангелова П., Бояджиев, Н., Иванова, А., Мулетаров, Сп., Башева, Й. (2010). Антропометрична и функционална характеристика на елитни състезателки по аеробика в началото и в края на подготвителния им период, *Научни трудове на Съюза на учените в България* – Пловдив, т. XII, *Научна сесия ,,Медицина и дентална медицина",* стр. 38-41.

Angelova, P., Boyadzhiev, N., Ivanova, A., Muletarov, Sp. (2011). Vazrastovi razlichiya v adaptaciyata na organizma kam submaksimalni fizicheski natovarvaniya, *Nauchni trudove na Sayuza na uchenite v Bulgaria* – Plovdiv, t. XIV, 2012, Nauchna sesiya "Tehnika, tehnologii, estestveni I humanitarni nauki", str. 99-104. // Ангелова, П, Бояджиев, Н., Иванова, А., Мулетаров, Сп. (2011). Възрастови различия в адаптацията на организма към субмаксимални физически натоварвания, *Научни трудове на Съюза на учените в България – Пловдив*, т. XIV, 2012, Научна сесия, Техника, технологии, естествени и хуманитарни науки", стр. 99-104.

Angelova, P., Boyadjiev, N., Ivanova, A., Muletarov, Sp. (2012). Changes in the physical working capacity, body composition and fat metabolism of women on a three-month specialized training and dietary program, *Scripta Sientifica Medica,* vol. 44 (1), Supplement 1, pp. 81-83.

Balch, F., Balch, Dzh. (2005). *Recepti za lechenie s hrani I hranitelni dobavki*, IK "Kibea", Sofia. // Балч, Ф., Балч, Дж. (2005). *Рецепти за лечение с храни и хранителни добавки*, ИК Кибеа, София.

Banasiak, K. (2003). *Formulating with fruit food product design*. http://www.foodproductdesign.com Retrieved on 20.12.2019

Braun, H., Koehler, K., Geyer, H., Kleinert, J., Mester, J., Schänzer, W. (2009). Dietary Supplement Use Among Elite Young German Athletes. *International Journal of Sport Nutrition & Exercise Metabolism*, 19(1), 97-109.

Burke, L. M, Cato, L. (2015). Supplements and sports foods. En: L.M. Burke, in V. Deakin (Eds), *Clinical Sports Nutrition 5th ed.* Australia: McGraw- Hill Pty Ltd. Pp. 493-591

Caballero, M. G. A., Aguilar, A. M. Del C. T. (2017). *Caracterización de macrocomponentes en pulpa congelada de tres biotipos de ucuma (Pouteria lucuma)*. Universidad San Ignacio De Loyola. 1-126.

Dimitrova, D. (2014). *Hranene I sport,* NSA Pres, Sofia. // Димитрова, Д. (2014). *Хранене и спорт*, НСА Прес, София.

Dini, I. (2011). Flavonoid glycosides from Pouteria ucuma (R. Br.) fruit flour. *Food Chemistry,* 124: pp.884-888.

Erazo S., Escobar, A., Olaeta, J. & Undurraga, P. (1999). Determinacion proximal y carotenoids totals de frutos de deis selecciones de lucuma (Pouteria lucuma). *Alimentos*, 24, pp.67-75.

Fuentealba C., Galvez, L., Cobos, A., Olaeta, J. A., Defilippi, B. G., Chirinos, R., Compos, D., Pedreschi, R. (2016). Characterization of main primary and secondary matabolites and in vitro antioxidant and antihyperglycemic properties in the mesocarp of three biotypes of Pouteria lucuma. *Food Chemistry*, 190, pp.403-411.

Gachev, Em., Djarova, Tr. (2003). *Biohimiya*, izdatelstvo "Novi znaniya", Sofia. // Гачев, Ем., Джарова, Тр. (2003). *Биохимия*, изд. Нови знания, София.

Ghouila, Z., Laurent, S., Boutry, S., Vander Elst, L., Nateche, F., Muller, R. N., Baaliouamer, A. (2017). Antioxidant, antibacterial and cell toxicity effects of polyphenols Fromahmeur bouamer grape seed extracts. *Journal of Fundamental and Applied Sciences,* 9(1): pp. 392-420.

Ivy, J.L, Kammer, L., Ding, Z., Wang, B., Bernard, J.R., Liau, Y.H. & Hwanq, J. (2009). Improved cycling timetrial performance after ingestion of a caffeine energy drink. *International Journal of Sport Nutrition and Exercise Metabolism*, 19(1):61–78.

Maughan, R. J., Greenhaff, P. L. & Hespel, P. (2011). Dietary supplements for athletes: emerging trends and recurring themes. *Journal of Sports Sciences*, 29 (sup1), S57-S66.

Mukta, N., Mishra S., Srivastava A. (2017). Different Types of Super Food Product Its Sensory Evaluation Storage and Packaging. *International Journal of Advance Research, Ideas and Innovation in Technology*, 3 (6), pp. 812-820.

Rica, R.L., Evangelista, A.L., Maia, A.F., Machado, A.F., La Scala Teixeira, C.V., Barbosa, W. A., Hacbart, F. N., Guerra Junior, M. A., Ferreira, L. G., Gomes, J. H., Mendes, R. R., Miranda, J. M. Q., Viana, M. V., Baker, J. S., Bocalini, D. S. (2019). Energy drinks do not alter aerobic fitness assessment using field tests in healthy adults regardless of physical fitness status, *Journal of Physical Education and Sport (JPES),* Vol 19 (Supplement issue 1), Art 17, pp. 113 – 120.

Rojo, LE., Villano, CM., Joseph, G., Schmidt, B., Shulaev, V., Shuman, JL., Lila, MA., Raskin, I. (2010). Wound-healing properties of nut oil from Pouteria Lucuma.

Journal of Cosmetology & Dermatology, 9, pp. 185–195.

Sánchez-Oliver, A. J., Mata-Ordoñez, F., Domínguez, R., López-Samanes, A. (2018). Use of nutritional supplements in amateur tennis players, *Journal of Physical Education and Sport (JPES),* Vol 18, issue 2, Art. 114, pp. 775 – 780

U.S. Department of Health and Human Services and U.S. Department of Agriculture. (2015–2020) *Dietary Guidelines for Americans.* 8th Edition. December 2015.

Verbeke, W. (2006). Functional foods: Consumer willingness to compromise on taste for health. *Food Qual. And Prefer.* 17(1), pp.126–131.

Villanueva, M., C.M. (2002). *Cultivo ucumaial de la ucuma en Perú y el mercado internacional.* Lima, Perú.

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