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THE INFLUENCE OF EATING DULCE DE LECHE AS A PRE-WORKOUT ON ATHLETES' PERFORMANCE IN AEROBIC EXERCISE

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Abstract: This study evaluated the impact of eating dulce de leche as a pre-workout food on the aerobic performance of runners. The study involved two exercise sessions on a treadmill, with a minimum interval of three days between them, one without the consumption of dulce de leche and the other with the ingestion of 40g of dulce de leche, 30 minutes before training, on a fixed 5km route. The results showed a significant reduction in average running time (260.2 seconds; p=0.025) after consumption, with a large effect size (d=1.56). Statistical analyses were carried out using R software (version 4.3.0). It was concluded that dulce de leche, as a source of rapidly absorbed carbohydrate, can improve performance in aerobic exercise by keeping blood glucose stable. Although the small sample size (n=5) requires caution when generalizing, the study shows that dulce de leche can be a viable option for athletes looking to improve their performance and that the carbohydrate effect suggests that it is functional for active individuals, regardless of specific anthropometric characteristics.
Keywords: dulce de leche; aerobic performance; running; sports nutrition; treadmill; glycemic index.

HYPOTHESIS

Consuming dulce de leche before aerobic exercise can increase the availability of energy and improve the performance capacity of athletes, due to the rapid supply of carbohydrates and the potential optimization of energy metabolism during physical activity.

BACKGROUND

The justification for this study is based on the importance of understanding how pre-workout nutrition can influence athletes' performance during aerobic exercise. Dulce de leche is a source of simple carbohydrates that can provide quick energy, making it a potentially convenient option for athletes who are looking to improve their performance. Investigating the effects of dulce de leche consumption on aerobic exercise can provide valuable insights into nutritional strategies for optimizing sports performance, as well as contributing to the development of more precise and individualized nutritional recommendations for physical activity practitioners.

OBJECTIVE

The general aim of this study was to investigate the influence of the consumption of dulce de leche as a pre-workout on the performance of runners during an aerobic exercise, measured by the time needed to cover a fixed distance of 5 km, associated with the power of the exercise, in the city of Fernandópolis-SP.

SPECIFIC OBJECTIVES

- Propose a practical guide for consuming dulce de leche as a pre-workout for individuals who practice running.
- To evaluate the time taken by athletes to cover 5 km in running sessions with and without the consumption of dulce de leche as a pre-workout.
- To analyze the variation in running time according to the athletes' individual characteristics, such as weight, height, Body Mass Index (BMI) and body fat percentage.
- To see if the consumption of dulce de leche significantly influences the performance of runners in aerobic activities.

INTRODUCTION

Endurance running is a long-distance sport that emphasizes participants' physical and mental endurance. Runners face challenges such as maintaining a constant pace, dealing with fatigue and physical discomfort, and facing varied conditions. From a scientific point of view, this sport offers opportunities to study the effects of prolonged exercise on the human body, including exercise physiology, adaptation to training, nutrition and hydration. It also makes it possible to explore issues such as pain control, motivation and behavior during strenuous activities, providing useful insights for athletes, coaches and health professionals (Ørtenblad et al., 2013).

The main source of energy for physical exercise is carbohydrates (CHO), so it is essential that energy consumption, as well as the proportion of macronutrients and CHO is adequate to meet needs and maintain performance during exercise (Burke et al., 2018).

Carbohydrates are stored in the form of muscle and liver glycogen, and muscle glycogen provides energy for the muscle itself, thus explaining the need to maintain adequate levels (Bergström et al, 1967).

In addition, maintaining blood glucose levels at the time of exercise directly influences performance, since hypoglycemic episodes cause weakness, dizziness, fatigue (Ørtenblad et al., 2013).

In this context, the study aims to investigate whether the consumption of dulce de leche before training influences sports performance and the glycemic profile of this public before and after training.

The study seeks not only to fill scientific gaps, but also to provide information that contributes to increasingly personalized nutritional strategies, prioritizing biochemical individuality, for people who exercise. The clinical implications of these findings may transcend the laboratory sphere, directing health professionals towards more precise guidelines.

METHODOLOGY

This is a quantitative, experimental and longitudinal field study. With runners from the city of Fernandópolis-SP at the Academia Escola da Fundação Educacional de Fernandópolis-FEF.

The study began only after approval by the Ethics Committee of the Brazil Platform, through the substantiated opinion of CEP number 7.290.209.

The inclusion criteria were: runners aged between 18 and 50; athletes of both sexes; athletes who practiced aerobic exercise regularly, at least three times a week; athletes who did not have health conditions that prevented them from participating in intense physical activity.

The exclusion criteria were as follows: athletes with any medical condition that directly affects performance during aerobic exercise; athletes using medication and/or supplements that could interfere with the results of the research; athletes with allergies to cow's milk protein and/or lactose intolerance, or with restricted sugar consumption; athletes who did not comply with the ICF (informed consent form).

The initial sample was 30 (thirty) participants, and after selection using the inclusion and exclusion criteria, the "n" was 9 (nine) participants. Of these, 4 (four) dropped out and 5 (five) remained until the end of the study, making up the final "n" for this study.

An anamnesis was taken to identify the participants with the following data: name, date of birth, length of time practicing endurance and whether they used any supplements or had any pathologies.

Body mass was measured using a digital scale (Multilaser Digi-Health), height using a tape measure (Avanutri), Body Mass Index (BMI) and body fat percentage. BMI was calculated as weight (in kilograms) divided by height squared (in meters), while fat percentage was estimated using Jackson and Pollock's (1978) seven fold method with the aid of

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Participants	Age	Weight (kg)	Height (cm)	BMI (kg/m²)	% Fat	Time without candy	Time with candy
1	53	56,1	161	21,6	14,6	31:16	28:32
2	21	73,7	170	25,5	17	39:12	30:35
3	22	72	182	21,74	14,9	31:08	30:00
4	21	78	171	26,7	13,2	26:09	22:35
5	29	63,4	172	21,42	18	38:11	32:33

Table 1 - Profile Variables of the Participants and Their Respective Running Times.
Source: Own authorship, 2025.
Caption: Data components of the participants' profiles and their respective running times in the conditions without and with consumption of 40g of dulce de leche.

a scientific adipometer (Lange). These measurements were taken in order to characterize the sample of study participants.

The instructions given to the research participants were that they should follow their usual diet, with the same menu every time, as long as they had a protein source and a carbohydrate source and, above all, that the training should not be done in a fasted state. And they had to do it at least 2 hours before the start of the aerobic exercise being assessed. The training sessions took place in the morning, from 8am to 11am, in order to reduce possible biases related to the participants' diet before the training sessions.

To perform the tests, the participants were instructed to have a good hydration of 500ml of water in the two hours before the training (ACSM, 2016).

Training took place in two sessions, with a minimum interval of three days between each. All participants were subjected to the two training conditions (with and without the use of dulce de leche). In one session, the participants trained without consuming dulce de leche, while in the other session, consumed 40g of dulce de leche before training.

For the sessions in which dulce de leche was used as a pre-workout, it was carefully monitored in terms of quantity on a digital nutritional scale. The dulce de leche was consumed in a controlled manner, exactly 30 minutes before the start of the aerobic exercise.

The aerobic exercises were carried out on a professional Lion Fitness X4-GT treadmill and the sessions had a fixed distance of 5 km. The time was recorded to evaluate the athlete's performance in the distance covered in relation to the consumption and non-consumption of dulce de leche.

To analyze the data, a paired Student's t-test was used to compare running times before and after eating dulce de leche. The effect size was calculated using Cohen's d. The normality of the data was checked using the Shapiro--Wilk test, and the homogeneity of variances was assessed. The significance level adopted was $\alpha = 0.05$. The analyses were carried out using R software (version 4.3.0).

RESULTS AND DISCUSSION

The study sample consisted of five participants, two women and three men, aged between 21 and 53 years (average: 29.2 ± 12.3 years). The participants' weight ranged from 56.1 kg to 78 kg, with an average of 68.84 ± 8.7 kg. The average body mass index (BMI) was 23.78 ± 2.2 kg/m², ranging from 21.4 to 26.7 kg/m² (from eutrophic to overweight). Body fat percentage ranged from 13.2% to 18% (mean 15.54%± 1.93%), within the healthy range for recreational athletes and indicating low variability between participants.

As for age variability, despite the range (21-53 years), all the participants were active, suggesting that the effect of dulce de leche can be observed in different age groups.

Regarding body composition, BMI and % fat showed no clear correlation with improved performance, indicating that the effect of carbohydrate may be independent of these factors. And this lack of a clear pattern between BMI or % fat and improved performance suggests that the effect of carbohydrate may be generalizable to active individuals, regardless of specific anthropometric characteristics.

Individual differences in the response to dulce de leche (reductions of 1:08 to 8:37) may reflect variability in carbohydrate metabolism, body composition or previous adaptation. For example, participant 2 (male, 21 years, BMI 25.5) had the greatest reduction (8:37), possibly due to greater efficiency in glucose utilization, while participant 3 (male, 22 years, BMI 21.7) had a lower response (1:08), suggesting slower digestion or insufficient energy reserves. These findings highlight the importance of personalizing nutritional strategies.

Statistics	Time without dulce de leche	Time with dulce de leche
Average	1991.2 s (~33m 11s)	1731.0 s (~28m 51s)
Standard deviation	326,63 s	227,27 s
Minimum	1569 s	1355 s
Maximum	2352 s	1953 s
Median	1876 s	1800 s

Table 2 - Descriptive Statistics of Running Times.
Source: Own authorship, 2025.
Legend: Mean, standard deviation, minimum and maximum values of the participants' running times in the conditions without and with dulce de leche consumption.

The average difference in running time between the conditions without dulce de leche and with 40g of dulce de leche was approximately 260.19 seconds (4 minutes and 20 seconds), indicating that the participants, on average, were faster after consuming the pre-workout.

The standard deviation of the running times helps us to understand whether all the participants had a similar response to the dulce de leche or whether there was a great deal of individual variation.

Low standard deviation: the participants' times are close to the average, which represents a more consistent effect.

High standard deviation: times vary greatly between participants, which may indicate that the effect of dulce de leche depends on other individual factors.

The standard deviation of the times without dulce de leche was higher than with dulce de leche, which suggests that after consuming the pre-workout, the participants had a more homogeneous response.

The deviation was calculated according to the formula below:

Where:

- s is the standard deviation of the sample.
- n is the number of elements in the sample.
- xi are the individual data values.
- x is the sample mean.

The standard deviation of the times without dulce de leche was higher than with dulce de leche, which suggests that after consuming the pre-workout, the participants had a more homogeneous response.

Participants	Time without candy (s)	Time with jam (s)	Difference (s)
1	1876 (31:16)	1712 (28:32)	164
2	2352 (39:12)	1835 (30:35)	517
3	1868 (31:08)	1800 (30:00)	68
4	1569 (26:09)	1355 (22:35)	214
5	2291 (38:11)	1953 (32:33)	338

Table 3 - Running Time Data and Their Respective Differences (at seconds).
Source: Own authorship, 2025.
Caption: Table comparing the running times (in seconds) of 5 participants in the conditions without and with consumption of 40g of dulce de leche as a pre-workout. The "Difference" column represents the reduction in running time after consumption (Time without jam - Time with jam). Positive values indicate improved performance. The times were measured over identical courses (5km), under similar weather conditions (indoor).

The individual differences (without jam - with jam) are: 164, 517, 68, 214, 338.

- **Average difference ($\bar{d}$):** 260.2 s

$$\bar{d} = \frac{164 + 517 + 68 + 214 + 338}{5} = \frac{1301}{5} = 260.2 \text{ s}$$

- **Confidence interval (95% CI):** 58.1 s to 462.3 s

$$\text{IC} = \bar{d} \pm t_{\text{crítico}} \times EP = 260.2 \pm 2.776 \times 74.6 \approx [58.1 \text{ s}, 462.3 \text{ s}]$$

- **Standard deviation of differences (s):** 166.8 s

$$s = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n-1}} = \sqrt{\frac{(164 - 260.2)^2 + (517 - 260.2)^2 + \cdots + (338 - 260.2)^2}{4}} \approx 166.8$$

- **Student's t-test formula:**

$$t = \frac{\bar{d}}{s/\sqrt{n}}$$

Where:
$\bar{d}$ is the average of the differences.
s is the standard deviation of the differences.
n is the sample size.

- **Calculating the value of t:**

$$t = \frac{260.2}{166.8/\sqrt{5}} = \frac{260.2}{74.6} \approx 3.49$$

- **Degrees of freedom (gl):**

$$gl = n - 1 = 4$$

- **p-value**

Approximately 0.025 (bilateral) or 2.5%.
As $p < 0.05$, the null hypothesis was rejected.

- **Critical value of t (α = 0.05, two-sided):**

For gl=4 and α=0.05 (significance level), the critical value of t is 2.776

The calculated value of t (3.49) is greater than the critical value (2.776).

The results show that the consumption of 40g of dulce de leche before exercise significantly influenced the participants' performance. The average running time was reduced by 260.2 seconds (approximately 4 minutes and 20 seconds) after eating the dulce de leche, with a 95% confidence interval between 58.1 and 462.3 seconds. This difference was statistically significant ($t(4) = 3.49$; $p = 0.025$), indicating that the intervention had a positive impact on the aerobic performance of the individuals.

The effect size (Cohen's d = 1.56) is considered large, suggesting that the consumption of dulce de leche had a substantial influence on physical performance. This finding can be explained by the role of carbohydrates in maintaining blood glucose during exercise. When consumed around 30 minutes before training, dulce de leche provides a quick source of glucose, preventing drops in blood glucose that could lead to symptoms such as dizziness, fatigue and a drop in performance.

The data was analyzed using the R software (version 4.3.0), using a paired t-test with a significance level of α = 0.05. Assumptions of normality (Shapiro-Wilk test) and homogeneity of variances were verified.

During endurance exercise, such as running, the glycolytic pathway is predominant in the production of ATP, requiring an adequate supply of carbohydrates and oxygen. The consumption of dulce de leche before training favours this scenario, ensuring that blood glucose is high and available to the muscles, reducing the need to mobilize liver and muscle glycogen. This may explain the improvement observed in the participants' performance.

According to Jeukendrup (2014) and Thomas, Erdman and Burke (2016) the composition of the carbohydrate consumed pre-workout is fundamental. When consumed close to the start of exercise, a carbohydrate with a high glycemic index, such as dulce de leche, is recommended to allow for rapid absorption and energy utilization. If you eat earlier in the day, carbohydrates with a lower glycemic index, combined with fats and proteins, may be more suitable, as they promote a gradual release of energy, avoiding gastrointestinal discomfort.

Condition	Average (s)	Standard Deviation (s)	Mean Difference (s)	95% CI	t(4)	p
No dulce de leche	1991,2	326,6	260,2	58,1; 462,3	3,49	0,025
With dulce de leche	1731,0	227,3				

Table 4 - Summary of statistical analyses.
Source: Own authorship, 2025.

However, it is important to note that the sample size (n = 5) is small, which limits the generalizability of the results. In addition, individual factors such as metabolic adaptation and nutritional status may have influenced the participants' response. Future studies with larger samples and different consumption protocols are needed to confirm these findings and explore additional variables, such as the interaction between carbohydrate intake and different types of training.

CONCLUSION

This study evaluated the influence of consuming 40g of dulce de leche before aerobic exercise on the performance of runners. The results indicated a significant reduction in running time after eating the sweet, suggesting that this nutritional strategy may be beneficial for optimizing physical performance.

The findings reinforce the hypothesis that maintaining blood glucose is essential for sports performance, especially in endurance sports which rely on the glycolytic pathway for energy generation. Pre-workout consumption of fast-absorbing carbohydrates can help improve performance, avoiding drops in blood glucose that could compromise the athlete's performance.

However, the small sample size limits the generalizability of the findings, making further research necessary to better understand the effects of dulce de leche as a pre-workout carbohydrate source in different sporting contexts. In addition, other future recommendations could include: investigating effects at different exercise intensities, testing other fast carbohydrate sources and evaluating the impact on professional vs. recreational athletes. Nevertheless, this study highlights the potential of this nutritional approach and suggests that dulce de leche may be a viable option for athletes looking to improve their performance.

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