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EFFECT OF THE GLYCEMIC INDEX OF SELECTED TYPES OF DATES ON METABOLIC RESPONSE AND PHYSICAL PERFORMANCE IN TRAINED ATHLETES

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Abstract

This study used a randomized controlled trial with thirty (30) volleyball athletes. They were given a fixed amount of carbohydrates (50-70 \mathrm{~g}) before physical activity, in accordance with existing guidelines for pre-exercise nutritional supplementation. Various measures were evaluated. Metabolic indicators included blood glucose concentration, insulin concentration, and lactate concentration. Physical fitness was also assessed through endurance tests. Significant differences were found between the three groups in blood glucose, insulin, lactate, and physical performance (\mathrm{p} \leq 0.05). Zahidi dates produced the most stable metabolic response, indicated by the lowest mean blood glucose (90 \pm 5 \mathrm{mg} / \mathrm{dL}) and insulin levels (9.2 \pm 1.1 \mu \mathrm{IU} / \mathrm{mL}) compared to Qaranfali and Medjool. Conversely, Qaranfali showed the highest physical performance results (1300 m) and the highest rate of improvement (16.0 %), followed by Medjool (1280 \mathrm{~m} ; 15.3 %) and Zahidi (1250 \mathrm{~m} ; 13.6 %). These results suggest that dates with a low glycemic index support metabolic stability, while those with a moderate glycemic index may be more beneficial for sports performance. Furthermore, the choice of date type should be tailored to the nature and timing of physical activity, as it is recommended to use dates with a low glycemic index before prolonged exercise to improve metabolic stability, while dates with a high glycemic index can be used for short-term activities or during periods of rapid recovery. The study concludes that dates are an effective and reliable natural food source for sports nutrition strategies. This opens the door to further applied research in various sports settings, especially in date-producing countries.

Keyword: Dates, Glycemic Index, Metabolic Response, Physical Performance, Athletes natural carbohydrates.

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INTRODUCTION

Sports nutrition is one of the fundamental pillars in improving physical performance and athletic achievement, as carbohydrates play a pivotal role in supplying

the body with the necessary energy during physical activity, in addition to their role in recovery.

Muscle glycogen storage after exercise (Aubert, S et al., 2021; Silva et al., 2025).

The scientific literature shows that the type and timing of carbohydrate intake can directly influence physiological response and athletic performance, particularly Regarding blood sugar regulation and insulin response (Kuswoyo et al., 2017; Purwanto et al., 2025; Sarmiento et al., 2024).

In this context, the concept of the glycemic index is used as a scientific tool to classify carbohydrate-rich foods based on their speed in raising blood glucose levels, with studies indicating that low-glycemic-index foods (Hameed, 2025; Morral-Yepes et al., 2023).

Glycemics contribute to a gradual and sustained energy supply, whereas high-glycemic-index foods lead to a rapid rise in blood sugar followed by a relatively sharp drop (Gillbanks, 2020).

Dates are a natural food source rich in carbohydrates, containing varying proportions of glucose and fructose, along with smaller amounts of sucrose, giving them unique metabolic properties that make them suitable For use in sports nutrition (Blongkod, 2022; Hawley et al., 2006).

The dates are also rich in essential minerals such as potassium, which are important in enhancing muscle performance and lowering exhaustion during workouts (Abarghoueinejad et al., 2021; Adewale et al., 2024; Rossi et al., 2017).

Although these qualities are very nutritious, it is important to note that the different glycemic indexes of various dates affect their performance in boosting physical efficiency.

Some studies have shown that certain types.

Carbohydrates consumed before exercise can affect endurance, energy expenditure, and fatigue levels (Charles et al., 2017; Bagus Wahyu Prastyo et al., 2017; Bassett, 2000).

However, studies examining the effects of different date varieties on metabolic and exercise-related responses remain limited.

This gap is particularly relevant because date varieties such as Zahidi, Qaranfali, and Medjool may differ in their glycemic characteristics, sugar composition, fiber content, and potential influence on blood glucose regulation and exercise performance.

Therefore, investigating these varieties is important not only within Arab dietary contexts, where dates are commonly consumed, but also for understanding how their distinct nutritional profiles may affect energy availability and metabolic stability during exercise.

Based on the above, the importance of studying the effect of the glycemic index of different types of dates on the metabolic response and physical performance of athletes becomes clear, with the aim of reaching accurate scientific recommendations that can be applied in the field of training and sports nutrition.

Importance of the Research:

The importance of this study stems from the fact that it sheds light on one of the important aspects of sports nutrition, which is Using natural carbohydrate sources is an effective alternative to artificial dietary supplements.

Studies indicate that relying on natural foods may provide additional benefits related to metabolic response and overall health (Abduh et al., 2024; Bhattad & Pacifico, 2022).

The importance of this research also lies in its link between the glycemic index and the physiological response of athletes, which helps in understanding how different types of dates affect blood sugar regulation and insulin secretion, and thus improve performance.

Energy use efficiency during physical performance (Baiget et al., 2014; Baláš et al., 2012; Booth & Orr, 2016).

From a practical standpoint, the results of this study can contribute to: Developing sports nutrition strategies based on local resources (dates).

Reducing reliance on expensive nutritional supplements.

Improving physical performance and recovery in athletes.

This study provides scientific guidance for coaches and nutritionists on selecting the appropriate type of dates based on the nature of the athletic activity (Impellizzeri et al., 2020; Komalasari, 2023).

Furthermore, this study represents a significant scientific contribution to the field of sports nutrition, particularly in sports environments.

Date cultivation is widespread in many Arab regions, which enhances the applied and economic

relevance of this research.

By examining the nutritional and physiological value of locally available date varieties, this study also supports the broader concept of food sovereignty, as it highlights the potential of culturally rooted and regionally produced foods to contribute to health, exercise nutrition, and sustainable dietary practices.

Research Problem:

Despite the widespread consumption of dates in daily diets, including among athletes, limited evidence has specifically examined how the glycemic index of different date varieties affects metabolic responses and physical performance.

Previous studies on carbohydrate intake and exercise have reported inconsistent findings: low-glycemic foods are often associated with more stable blood glucose and insulin responses, whereas moderate- or high-glycemic carbohydrates may provide faster energy availability and improve short-term performance.

These conflicting findings indicate the need to compare date varieties with different glycemic characteristics to clarify their specific effects on glucose regulation, insulin response, lactate accumulation, and exercise performance.

The research problem lies in the lack of clarity regarding which types of dates are most suitable for use at different times of physical activity, whether before, during, or after exercise, given the variation in their glucose and fructose content.

This affects blood sugar regulation and insulin levels.

Furthermore, many current sports nutrition recommendations are derived from studies using artificial carbohydrate sources, such as gels or sports drinks, and from populations whose habitual diets differ from those of communities where dates are regularly consumed.

This distinction is important not merely as a geographical issue, but as a physiological and dietary-adaptation factor, because habitual exposure to local carbohydrate sources may influence glucose regulation, insulin response, gastrointestinal tolerance, and energy utilization during exercise.

Therefore, this research seeks to answer the following main question: What is the effect of the glycemic index of different types of dates on metabolic response and physical performance in

Research Objectives:

This research aims to study the physiological and physical effects of varying glycemic indexes of selected date varieties on athletes, by achieving the following objectives: To examine the effects of the glycemic index of different date varieties, namely Zahidi, Qarnafli, and Medjool, on the integrated metabolic response and physical performance of trained athletes.

To analyze the interconnected biochemical responses, including blood glucose, insulin, and lactate levels, after consuming different date varieties before exercise, and to determine how these metabolic changes are associated with physical performance outcomes.

METHOD

The researcher adopted the experimental method using the Randomized Controlled Design (RCD) for equivalent groups. This design is suitable for studying the effect of nutritional interventions on physiological response and physical performance.

It is one of the most accurate designs for controlling extraneous variables, thus enhancing the validity of the results (Tahsin Hussein Rassul, 2023).

The sample members were randomly distributed into three experimental groups according to the type of dates consumed, based on the difference in the glycemic index, with the aim of studying its effect on metabolic response and physical performance.

The research population consisted of volleyball players from local sports clubs.

A total sample of 30 trained volleyball players was selected and divided into three groups of 10 participants each.

The sample size was considered adequate based on an a priori power analysis for one-way ANOVA with three groups,

assuming a medium effect size, a significance level of 0.05 , and statistical power of 0.80 .

This calculation indicated that approximately 30 participants were sufficient to detect statistically meaningful differences among the groups.

Articipants were male volleyball players aged 18-25 years who were randomly selected from local sports clubs.

To be included, players had to meet the criteria for trained athletes, defined as having at least two years of structured volleyball training, participating in regular training at least three times per week, and having experience in club-level or regional competitions.

Players with recent injuries, chronic disease, or metabolic disorders were excluded from the study.

The sample was divided into three equal groups (10 players per group): Low glycemic index dates (Zahidi), Medium glycemic index dates (Qarnafli), High glycemic index dates (Medjool).

Sample Description:

Variable	Zahidi	Qaranfali	Medjool
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	x	sd	X	sd	x	sd
Age years	21.3	1.2	21.5	1.4	21.2	1.3
Height cm	178.5	4.2	179.1	3.8	178.8	4.0
Weight kg	72.4	5.3	73.1	4.8	72.8	5.0

Table 1.
Descriptive Characteristics of the Research Sample (Mean \pm Standard Deviation)

Equivalence and Homogeneity

To ensure the accuracy of the results, the equivalence of the groups was tested before the start of the experiment in the basic variables (age, height, weight), using a oneway ANOVA test.

Variable	SS	df	MS	F	Sig
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Age	0.84	2.0	42.0	31.0	73
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Height	1.92	2.0	96.0	28.0	75
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Weight	3.45	2.1	72.0	36.0	69
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Table 2.
Results Of The Homogeneity Test Between Groups Before The Experiment

*Sig values greater than (0.05) indicate no statistically significant differences between the groups, which indicates their homogeneity and equivalence, a prerequisite for ensuring that subsequent differences are attributable to the independent variable (Field, 2013).

Group	Type of dates	Glycemic index	Timing of intake
First	Zahidi	Low	30 minutes before exercise
Second	Qaranfali	Medium	30 minutes before exercise
Third	Medjool	High	30 minutes before exercise

Table 3.
Distribution Of Experimental Groups

Measurement Tools

Variable	Tool	Unit of Measurement
Blood sugar	Glucometer	$\mathrm{mg} / \mathrm{dL}$
Insulin	Laboratory analysis	$\mu \mathrm{IU} / \mathrm{ml}$
Lactate	Lactate Analyzer	$\mathrm{mmol} / \mathrm{L}$
Physical performance	Yo-Yo Intermittent Recovery Test	meter

Table 4.
Measuring instruments used

Experimental Procedures

The experiment was conducted according to the following steps: Preparatory Phase: Explaining the study objectives to the participants Obtaining written consent, Implementing a standardized diet 24 hours prior to the test, Restricting the intake of dietary supplements, Practical phase: Consume dates with an amount of (50-70 g of carbohydrates) 30 minutes before exercise (Cathryn R. Dooly & Arthur T. Johnson, 2014; Silva et al., 2025).
Take measurements as shown in the following table.

Measurement Timing

| Variables | Before intake | After 30 minutes | After exerciseAfter exercise |

|

Blood sugar checkmark checkmark checkmark|

Insulin checkmark checkmark checkmark|

Lactate boldsymbol x boldsymbol x checkmark|

Physical performance boldsymbol x boldsymbol x checkmark|

Table 5.
Measurement Timing

Tests Used

The Yo-Yo Test was used to measure physical performance, as it is one of the approved tests for assessing aerobic capacity in athletes (Pang et al., 2006a, 2006b; Silva et al., 2025).
The data were analyzed using SPSS software, through: The data were analyzed using SPSS software by calculating the arithmetic mean and standard deviation, followed by a One-Way ANOVA test and an LSD post-hoc test to identify differences between groups.
A significance level of 0.05 was adopted in this study, following Field (2013).
To ensure the validity of the experiment, several factors were controlled, including standardized test time, exercise intensity, environment, and diet.
Ethical considerations were also observed throughout the study, including obtaining participant consent, maintaining data confidentiality, and ensuring the participants' right to withdraw from the study at any time.

RESULTS AND DISCUSSION

First: Metabolic Response to Blood Glucose and Insulin

| Variables | Group | \mathbf{x} | sd | F | Sig |

|

| Blood glucose (mg/dL) | Zahidi | 90 | 5 \mu m | 4.32 | 0.02 |

| | Qaranfali | 95 | 6 \mu m | - | - |

| | Medjool | 102 | 7 \mu m | - | - |

Zahidi 9 2 1 1 pm 5 12 0 01|

Insulin mu \mathrm{IU} \mathrm{ml}|

Qaranfali 10 0 1 3 pm|

Medjool 11 5 1 5 pm|

Table.
6 Means and Analysis of Variance for Blood Glucose and Insulin

Table 6 shows that the blood sugar results indicate statistically significant differences between the groups, as the low glycemic index (Zahidi) date group recorded the lowest increase in blood sugar compared to the group in the table. This is due to the slow rate of carbohydrate absorption and the slow rate of glucose entering the bloodstream. These results are similar to those shown where low-glycemic foods lead to More stable metabolism and fewer drastic changes in blood sugar levels.

In the case of insulin, the results have shown a higher increase in insulin levels in the high-glycemic (drug-filled) date groups, thus causing Greater insulin secretion in response to the faster increase in blood glucose level. This corroborates the findings of Jeukendrup, which shows that fast-acting carbohydrates can result in higher levels of insulin secretion.

It can be concluded that low glycemic-index dates are better suited to maintain metabolic stability during exercise.

Variables	Group	x	sd	F	Sig
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Lactate mmol L	Zahidi	6.809	pm	3.870	0.031
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Qaranfali	6.208	pm			
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Medjool	7.110	pm			
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Physical performance m	Zahidi	12.5080	pm	6.230	0.011
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Qaranfali	13.0085	pm			
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Medjool	12.8090	pm			
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Table 7.
Means and Analysis of Variance for Lactate and Physical Performance

Table 7 shows that the lactate results revealed significant differences between the groups, with the date group recording the lowest average glycemic index (pink) and lactate accumulation, indicating better energy efficiency. And it delays muscle fatigue.

This response may be explained by the balanced glucose and fructose composition of the date variety. At the molecular level, glucose is absorbed through sodium-dependent glucose transporters and rapidly enters the bloodstream, providing an immediate substrate for glycolysis and ATP production during exercise.

In contrast, fructose is primarily taken up through GLUT5 transporters and metabolized in the liver, where it can contribute to hepatic glycogen restoration and a more gradual release of energy substrates.

This dual absorption and metabolic pathway may reduce excessive fluctuations in blood glucose and insulin while maintaining carbohydrate availability for working muscles.

As a result, the balanced glucose-fructose profile may support sustained energy production, delay lactate accumulation, and improve endurance performance.

Group	Before (m)	After (m)	Improvement rate %
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Zahidi	1100	1250	13.6 %
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| Qaranfali | 1120 | 1300 | 16.0 % |

| Medjool | 1110 | 1280 | 15.3 % |

Table 8.

Rates of development among groups

The evolutionary ratios indicate the superiority of the pink date variety, which recorded the highest improvement in physical performance.

This can be explained by this variety's ability to achieve a balance between rapid energy supply and metabolic stability, as a result of its composition combines monosaccharides.

his balance also reduces rapid reliance on glycogen, thus prolonging performance before fatigue sets in.

CONCLUSION

In light of the study results and the statistical analysis using one-way ANOVA, the following conclusions can be drawn. The difference in the glycemic index of date varieties leads to significant differences in metabolic response, as low-glycemic index (Zahidi) dates showed better stability in blood sugar levels.

Dates have a high GI and trigger a sudden elevation in blood sugar, resulting in increased levels of insulin released for providing instant energy.

Qaranfali, the medium-glycemic-index date variety, appeared to provide a more favorable balance between metabolic response and physical performance, as reflected by relatively lower lactate levels during physical activity.

The results revealed that carbohydrate intake significantly influenced physical performance, particularly because the glucose-to-fructose ratio may improve energy production efficiency during volleyball-specific intermittent activity.

In volleyball athletes, rapid glucose availability supports immediate ATP production during explosive actions such as jumping, blocking, and spiking, whereas fructose metabolism may contribute to a more sustained supply of energy substrates during repeated rallies and recovery intervals.

Therefore, an appropriate glucose-to-fructose balance may enhance metabolic efficiency by supporting both rapid energy demands and sustained performance during volleyball activity.

Sports nutrition may include dates as a valuable source of natural foods because of their beneficial impact on physiological responses and performance.

RECOMMENDATIONS

Based on the results obtained from the research, the following recommendations are proposed:

The consumption of low glycemic index dates before engaging in prolonged exercises since they help in stabilizing blood sugar levels.

Consume dates with a high glycemic index during exercise or shortly after to restore energy quickly.

For endurance and fast energy training programs, dates with a medium glycemic index, for example, carnation dates.

Coaches and nutritionists should be encouraged to incorporate dates into the diets of athletes as a supplement to synthetic substances.

Further research should be conducted with more participants, as well as incorporating other hormones and muscle fatigue markers.

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The study concludes that dates are an effective and reliable natural food source for sports nutrition strategies.

This opens the door to further applied research in various sports settings, especially in date-producing countries.

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This research aims to study the physiological and physical effects of varying glycemic indexes of selected date varieties on athletes, by achieving the following objectives: To examine the effects of the glycemic index of different date varieties, namely Zahidi, Qarnaflī, and Medjool, on the integrated metabolic response and physical performance of trained athletes. To analyze the interconnected biochemical responses, including blood glucose, insulin, and lactate levels, after consuming different date varieties before exercise, and to determine how these metabolic changes are associated with physical performance outcomes.

METHOD

The researcher adopted the experimental method using the Randomized Controlled Design (RCD) for equivalent groups. This design is suitable for studying the effect of nutritional interventions on physiological response and physical performance. It is one of the most accurate designs for controlling extraneous variables, thus enhancing the validity of the results (Tahsin Hussein Rassul, 2023). The sample members were randomly distributed into three experimental groups according to the type of dates consumed, based on the difference in the glycemic index, with the aim of studying its effect on metabolic response and physical performance. The research population consisted of volleyball players from local sports clubs. A total sample of 30 trained volleyball players was selected and divided into three groups of 10 participants each. This calculation indicated that approximately 30 participants were sufficient to detect statistically meaningful differences among the groups. Participants were male volleyball players aged 18-25 years who were randomly selected from local sports clubs. To be included, players had to meet the criteria for trained athletes, defined as having at least two years of structured volleyball training, participating in regular training at least three times per week, and having experience in club-level or regional competitions. Players with recent injuries, chronic disease, or metabolic disorders were excluded from the study.

The sample was divided into three equal groups (10 players per group): Low glycemic index dates (Zahidi), Medium glycemic index dates (Qarnaflī), High glycemic index dates (Medjool).

Table 1.
Descriptive Characteristics of the Research Sample (Mean \pm Standard Deviation)

Equivalence and Homogeneity

To ensure the accuracy of the results, the equivalence of the groups was tested before the start of the experiment in the basic variables (age, height, weight), using a oneway ANOVA test.

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Table 2.
05) indicate no statistically significant differences between the groups, which indicates their homogeneity and equivalence, a prerequisite for ensuring that subsequent differences are attributable to the independent variable (Field, 2013).

Group	Type of dates	Glycemic index	Timing of intake
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First	Zahidi	Low	30 minutes before exercise
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Second	Qaranfali	Medium	30 minutes before exercise
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Third	Medjool	High	30 minutes before exercise
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Table 3.
Distribution Of Experimental Groups

Measurement Tools

Variable	Tool	Unit of Measurement
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Blood sugar	Glucometer	$\mathrm{mg} / \mathrm{dL}$
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Insulin	Laboratory analysis	$\mu \mathrm{IU} / \mathrm{ml}$
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Lactate	Lactate Analyzer	$\mathrm{mmol} / \mathrm{L}$
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Physical	Yo-Yo Intermittent	meter
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performance	Recovery Test	
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Table 4.

Measuring instruments used

Experimental Procedures

The experiment was conducted according to the following steps: Preparatory Phase: Explaining the study objectives to the participants Obtaining written consent, Implementing a standardized diet 24 hours prior to the test, Restricting the intake of dietary supplements, Practical phase: Consume dates with an amount of (50-70 g of carbohydrates) 30 minutes before exercise (Cathryn R. Dooly & Arthur T. , 2025).
Take measurements as shown in the following table.

Measurement Timing

Variables	Before intake	After 30 minutes	After exercise	After exercise
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Blood sugar	☒	☒	☒
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Insulin | ✓ | ✓ | ✓ |

Lactate | **✓** | **✓** | ✓ |

Physical performance | **✓** | **✓** | ✓ |

Table 5. , 2025).
The data were analyzed using SPSS software, through: The data were analyzed using SPSS software by calculating the arithmetic mean and standard deviation, followed by a One-Way ANOVA test and an LSD post-hoc test to identify differences between groups.
05 was adopted in this study, following Field (2013).
To ensure the validity of the experiment, several factors were controlled, including standardized test time, exercise intensity, environment, and diet.

Ethical considerations were also observed throughout the study, including obtaining participant consent, maintaining data confidentiality, and ensuring the participants' right to withdraw from the study at any time.

5 μ m | - | - |

Table.
6 Means and Analysis of Variance for Blood Glucose and Insulin

Table 6 shows that the blood sugar results indicate statistically significant differences between the groups, as the low glycemic index (Zahidi) date group recorded the lowest increase in blood sugar compared to the group in the table. This is due to the slow rate of carbohydrate absorption and the slow rate of glucose entering the bloodstream. These results are similar to those shown where low-glycemic foods lead to More stable metabolism and fewer drastic changes in blood sugar levels.
In the case of insulin, the results have shown a higher increase in insulin levels in the high-glycemic (drug-filled) date groups, thus causing Greater insulin secretion in response to the faster increase in blood glucose level. This corroborates the findings of Jeukendrup, which shows that fast-acting carbohydrates can result in higher levels of insulin secretion.
It can be concluded that low glycemic-index dates are better suited to maintain metabolic stability during exercise.

80 | 90 μ m | - | - |

Table 7.
Means and Analysis of Variance for Lactate and Physical Performance

Table 7 shows that the lactate results revealed significant differences between the groups, with the date group recording the lowest average glycemic index (pink) and lactate accumulation, indicating better energy efficiency. And it delays muscle fatigue.
This response may be explained by the balanced glucose and fructose composition of the date variety. At the molecular level, glucose is absorbed through sodium-dependent glucose transporters and rapidly enters the bloodstream, providing an immediate substrate for glycolysis and ATP production during exercise.
In contrast, fructose is primarily taken up through GLUT5 transporters and metabolized in the liver, where it can contribute to hepatic glycogen restoration and a more gradual release of energy substrates. This dual absorption and metabolic pathway may reduce excessive fluctuations in blood glucose and insulin while maintaining carbohydrate availability for working muscles.
As a result, the balanced glucose-fructose profile may support sustained energy production, delay lactate accumulation, and improve endurance performance.

Table 8.

Rates of development among groups

The evolutionary ratios indicate the superiority of the pink date variety, which recorded the highest improvement in physical performance.

This can be explained by this variety's ability to achieve a balance between rapid energy supply and metabolic stability, as a result of its composition combines monosaccharides. This balance also reduces rapid reliance on glycogen, thus prolonging performance before fatigue sets in.

CONCLUSION

In light of the study results and the statistical analysis using one-way ANOVA, the following conclusions can be drawn. The difference in the glycemic index of date varieties leads to significant differences in metabolic response, as low-glycemic index (Zahidi) dates showed better stability in blood sugar levels.

Dates have a high GI and trigger a sudden elevation in blood sugar, resulting in increased levels of insulin released for providing instant energy.

Qaranfali, the medium-glycemic-index date variety, appeared to provide a more favorable balance between metabolic response and physical performance, as reflected by relatively lower lactate levels during physical activity.

The results revealed that carbohydrate intake significantly influenced physical performance, particularly because the glucose-to-fructose ratio may improve energy production efficiency during volleyball-specific intermittent activity.

In volleyball athletes, rapid glucose availability supports immediate ATP production during explosive actions such as jumping, blocking, and spiking, whereas fructose metabolism may contribute to a more sustained supply of energy substrates during repeated rallies and recovery intervals.

Therefore, an appropriate glucose-to-fructose balance may enhance metabolic efficiency by supporting both rapid energy demands and sustained performance during volleyball activity.

Sports nutrition may include dates as a valuable source of natural foods because of their beneficial impact on physiological responses and performance.

RECOMMENDATIONS

Based on the results obtained from the research, the following recommendations are proposed:

The consumption of low glycemic index dates before engaging in prolonged exercises since they help in stabilizing blood sugar levels.

Consume dates with a high glycemic index during exercise or shortly after to restore energy quickly.

For endurance and fast energy training programs, dates with a medium glycemic index, for example, carnation dates.

Coaches and nutritionists should be encouraged to incorporate dates into the diets of athletes as a supplement to synthetic substances.

Further research should be conducted with more participants, as well as incorporating other hormones and muscle fatigue markers.

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