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HAEMATOCOCCUS PLUVIALIS PIGMENT AS A SUPPLEMENT FOR PARA-SWIMMERS: EVALUATING ITS IMPACT ON NUTRITIONAL PROFILES

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Adequate nourishment is a vital component of a healthier life and wellness, along with physical activity. This study aims to comprehend the special difficulties experienced by para swimmers in terms of their dietary intake, nutrient requirements, and general nutritional well-being through a quantitative methodology with the help of DietCal software.

The study involved 13 para-swimmers ranging in age from 20 to 50 years with different disability categories from S4 to S15. Their existing diet patterns and intake were assessed through a verified food frequency questionnaire and 24-hour diet recall, and the collected data were then interpreted using the software Diet Cal. Later on, both the recommended and received values of macro and micronutrients were compared.

A nutritional profile assessment indicates differences in nutrient intake from recommended levels. It was observed that para-swimmers were deficient in energy and nutrients such as protein, calcium, and iron, while over consuming nutrients like carbohydrates, fat, sodium, and magnesium.

This study concludes that there were nutrients deficient and over consumed in the diet of para-swimmers. Therefore, recommendations were made to adopt a balanced, nutrient-rich diet in addition to astaxanthin supplementation that the athletes were already taking to enhance athletic performance and promote overall well-being.

Key Words: Astaxanthin, DietCal, Nutrients, Nutritional assessment, Para-athletes.

Introduction

Historically, people with impairments have typically been addressed as "patients" by healthcare professionals and a large portion of the public as a whole. Although this perspective has changed, now they are called specially-abled people. The introduction of organized sports for people with disabilities in the mid-20th century, starting in Stoke Mandeville, England, in 1948, aimed to address the disparity in recreational opportunities[1]. The establishment of global organizations such as the International Paralympic Committee

in 1989 and the International Organization of Sport for the Disabled in 1959 and 1964, respectively, reflects a commitment to inclusivity in sports[2,3]. Many nations have regional organizations crucial for facilitating access to sports and leisure activities for individuals with disabilities. These initiatives provide talented disabled athletes with the opportunity to represent their country in Paralympic events. The Paralympic Games, occurring in the same city immediately following the Olympic Games since 1988, further promote inclusivity and equal participation in sports globally[4,5].They show a lot of courage, actively participate in competitions, give their best performances, and win medals. Now, they are known as para-athletes. In 2008, the International Paralympic Committee (IPC) identified five distinct disability categories during the Beijing Paralympic Games: spinal injury, amputee, visually impaired, cerebral palsy, and others[6]. The "Les Autres" category was designated for individuals facing physical limitations that did not align with the other specified categories, encompassing conditions such as arthrogryposis, dwarfism, and multiple sclerosis. Notably, athletes with intellectual disabilities were initially excluded from Paralympic events starting from the Sydney Games in 2000 but were reinstated in 2010. Individuals with disabilities exceeding the minimum standard are categorized based on their participation in sports[7,8]. While the specifics vary across sports, classifications are determined by either 1) the anatomical extent of the disability, such as the location of amputation or the degree of visual impairment, or 2) the functional consequences, like physiological effects from a spinal cord lesion's level. Accredited classifiers, aiming for fairness, assign athletes to a classification category through a thorough process. Clinical judgments rely on various assessments and each sport or disability group's regulations[9]. Taking Paralympic swimming as an example, all physically disabled athletes falls into one of ten classes. Those with milder disabilities receive higher numbers (e.g., S10), while those with more severe disabilities are assigned lower numbers (e.g., S1). It's essential to note that this classification method is sport-specific, meaning an individual may qualify for Paralympic swimming but not necessarily for other sports.

Para-swimming has emerged as a widely embraced sport, drawing competitors from approximately 100 nations, and it has become a fixture in every Paralympic Games. In the 1960 Paralympic Games in Rome, 77 swimmers from 15 countries participated, marking the sport's early global presence. Governed by the International Paralympic Committee and headquartered in Bonn, Germany, World Para Swimming serves as the sport's international governing body[10-12]. Para-swimming is inclusive, welcoming male and female athletes from all qualified impairment categories to participate in events like backstroke, breaststroke, butterfly, freestyle, medley, and relay. Para-swimmers have the option to utilize adaptive equipment, including starting blocks with handholds, tappers for signaling starts or turns, and various prosthetic swimming aids. The selection of equipment depends on the athlete's

classification and specific needs[13]. For individuals who are blind or visually impaired, auditory aids like beeps or verbal cues aid in starts and turns. Tappers or stroke counts are additional aids for swimmers with visual impairments[14]. Accurate race timing is ensured through electronic timing equipment. Para-swimmers adhere to a rigorous training routine encompassing pool sessions, strength and conditioning exercises, technique refinement, and race-specific training. Collaboration with coaches, sports scientists, and support personnel is integral to enhancing performance and preparing for competitive events[15].

Nutrition is a key factor influencing performance, and maintaining a healthy diet is essential for sustained, intense training without risking illness or injury. Optimal meal choices contribute to the body's ability to adapt to the stresses of exercise. Both coaches and athletes need to understand the importance of a nutritious diet[16]. Para-swimmers, like athletes in any competitive sport, require sufficient energy intake to meet the demands of training and competition. Research suggests that energy needs may vary based on factors such as body composition, exercise intensity, and individual metabolism. To support training, growth, and recovery, para-swimmers must consume an adequate amount of calories. A proper energy intake is fundamental to an athlete's diet as it promotes optimal bodily functions, enhances the ability to assimilate macro- and micronutrients, and assists in managing body composition[17]. The balance of carbohydrates, proteins, and fats in the diet of para-swimmers significantly influences their competition performance and recovery. Carbohydrates, being the primary energy source during vigorous exercise, should constitute a substantial portion of their diet. Lipids, serving as a concentrated energy source and contributing to hormone production, and proteins, essential for muscle growth and repair, are also vital components. Para-swimmers, akin to athletes in other sports, face the potential of experiencing energy imbalance, a condition where energy intake falls below energy expenditure[18],[19]. This imbalance can lead to inadequate refueling, nutrient deficiencies, and an elevated risk of accidents and illnesses. Additionally, certain athletes may engage in disordered eating patterns, such as an unhealthy fixation on body weight or restrictive eating, posing adverse effects on their overall health[20].A study was conducted by Marinho *et al*. with the objective of assessing the typical distributions of energy and micronutrient intake, and comparing the prevalence of inadequate or excessive micronutrient intake among Brazilian para-athletes, considering the presence or absence of scholarship support. The investigation revealed that para swimmers consistently exhibited deficiencies in crucial micronutrients, notably iron, vitamin D, and calcium. These deficiencies were correlated with compromised immunological function, suboptimal athletic performance, and an increased susceptibility to musculoskeletal issues[21].A systematic review examined that Para athletes face an increased risk of insufficient dietary intake, resulting in deficiencies in crucial nutrients essential for athletic performance. This heightened risk is

attributed in part to limited support and resources, particularly in the realm of sports nutrition education. Additionally, the combination of limited prior nutrition knowledge and the specific risks associated with various impairment types contributes to this issue. Concerns arise, particularly regarding inadequate levels of energy, carbohydrates, proteins, iron, and vitamin D in Para athletes[22].There is a pressing need for the assessment of these key nutrients, coupled with comprehensive sports nutrition education. Such initiatives are essential to empower Para athletes with the knowledge necessary to comprehend their individual nutrition requirements and optimize their athletic performance[23]. Sufficient nutrition is a crucial element for overall health and well-being, complementing physical activity so aim of this study seeks to explore the unique challenges faced by para-swimmers concerning their dietary intake, nutrient needs, and overall nutritional health. The investigation employs a quantitative methodology utilizing DietCal software.

Material and Methods

The study involved 13 para-swimmers ranging in age from 20 to 50 years with different disability categories from S4 to S15.Participants meeting the criteria for inclusion in this study were identified as active para-swimmers engaging in a minimum of three weekly training sessions for a duration of at least four years prior to the commencement of the research. To qualify, participants were required to abstain from drug or prescription medication use for a minimum of one year, possess no known medical conditions or diseases, refrain from smoking or alcohol consumption, and have no history of cardio-respiratory ailments. Strictly limited to active para-athletes, individuals failing to meet these inclusion criteria were excluded from the study. A written consent form, outlining general information and signed by participants, stipulated the utilization of their data for research purposes and their voluntary participation agreement. The document elucidated the study's objectives and the potential benefits of participant involvement. Following consent acquisition, any queries from participants were addressed to ensure comprehension.

Owing to the quantitative nature of the inquiry, the evaluation of participants' dietary habits and nutritional intake was conducted employing a validated food frequency questionnaire and a 24-hour diet recall for comprehensive data acquisition. The subjects were taking 4mg/day astaxanthin each morning after breakfast during 8 weeks observational study. Since the food frequency questionnaire was taken from the Harvard Chan School of Public Health and modified according to Rajasthani local cuisine, the validity of the questionnaire was already evaluated by the institute. Given that the survey constituted the primary methodological approach, the gathered data were subsequently analyzed using the Diet Cal software.

DietCal is intuitive and user-friendly software designed for efficient dietary management. It enables users to effortlessly track and analyze their daily food intake, including calories, macronutrients, and essential vitamins. A Food Frequency Questionnaire (FFQ) is a dietary assessment tool that quantifies the frequency and quantity

of various food and beverage consumption over a specific period, typically covering an extended duration, such as the past month or year. Participants respond to questions about their habitual intake of specific food items, providing valuable information for nutritional analysis and research on dietary patterns.

A 24-hour diet recall is a method employed for nutritional assessment, involving a structured interview where athletes are prompted to recall all food and beverage consumption within the preceding 24 hours. This process aims to ascertain an athlete's energy and macronutrient levels. Additionally, athletes were instructed to maintain a food history for subsequent assessments, facilitating an understanding of variations in energy intake over time.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software. The normality of the data was assessed utilizing the Shapiro-Wilk test. Descriptive statistics were presented as mean (±SD) for each variable. In the context of the data obtained in this study, the mean value, standard deviation, standard error of the mean, and independent 't' test were employed for data analysis. The significance level for all tests was set at $p < 0.05$.

Results and Discussion

In this research, we conducted a survey on para-swimmers to understand the unique challenges faced by them regarding their dietary intake, nutrient needs, and overall nutritional well-being using a quantitative methodology, facilitated by the utilization of the DietCal software.The research involved 13 para-swimmers, aged between 20 and 50 years. Within this group, 31% were in the 20-30 age range, 31% in the 30-40 age range, and 38% in the 40-50 age range. 85% percent of para-swimmers had participated at the national level, while 15% had competed at the state level. These para-swimmers represented various disability categories, ranging from S4 to S15, with 7% in the S4 category, 7% in the S5 category, 29% in the S7 category, 22% in the S10 category, 7% in the S12 category, 7% in the S13 category, and 7% in the S14 category. 15% of para-swimmers were taking supplements and 85 % were not taking any supplements. Due to the quantitative nature of the investigation, we utilized a validated food frequency questionnaire and a 24-hour diet recall to comprehensively assess the dietary habits and nutritional intake of the participants.

Nutritional Evaluation from Food Frequency Table (FFT)

Maintaining a well-balanced diet with adequate nutrient intake is crucial for athletes, especially those with special abilities. Special attention to their daily dietary needs is essential for optimizing performance and accelerating recovery. One method of evaluating their nutritional intake is through a food frequency questionnaire, with the collected data presented in a food frequency table. Table 1 typically summarizes the frequency of consuming various foods over a specified period, such as daily, weekly, or monthly. Observing the table reveals that a majority of athletes adhere to a vegetarian diet, yet many lack a properly planned nutritional regimen to address potential deficiencies and prevent overconsumption. Protein is particularly vital for para-swimmers, aiding in muscle repair and recovery, given the intensive use of limb muscles that may experience frequent wear and tear. Unfortunately, these

athletes often fall short of meeting their protein requirements. The consumption of green leafy vegetables is notably low among athletes, with only a small percentage incorporating greens into their diet, and even then, infrequently. On a positive note, most athletes include milk and dairy products in their daily intake. However, there is a contradiction as some athletes exhibit a high frequency of consuming saturated fats. Examining the dietary habits of the 13 para-swimmers, it is encouraging to find that eight members consume fruits daily. However, it is concerning that two members reported not consuming any fruit in the last month. This is particularly alarming since fruits contribute significantly to fluid intake and provide essential micronutrients. Additionally, three swimmers have wisely incorporated dry fruits into their pre-training meals, recognizing their value as a reliable energy source.

Table: 1. Food Frequency ssTable

Food	Never	1-3/ month	Weekly once	2-4/ week	5-6/ week	Once aday	2-3/ day	4-5/ day
Chicken/otherpoultry	11	1		1				
Milk	3					7	2	1
Whitebread	10	1	2					
Breakfastcereals	12					1		
Whiterice	5	5	1	2				
Pulses						13		
Chips	7	5		1				
Curd/buttermilk	2				2	9		
Eggboiled			1		1		1	
Cheese	11	2						
Ghee	3	1			1	2	5	1
Paneer	3	6	1	3				
Biscuits	8	2	1	2				
Icecreams,chocolates	8	4	1					
Driedfruits	8	2				3		
Sweets		2		5				
Sugar	5				1	4	3	
Nuts	8	1		1		2	1	
Tea/coffee	4	1			1	5	2	
Carbonateddrink	9	2	2					
Fruits	2			1	2	6	2	
Vegetables	2				2	1	7	1
Greens	6	3	3		1			
Tubers	6		3	3	1			

24 - Hour Diet Recall

A 24-hour diet recall method was used to assess all food and beverage consumption within the preceding 24 hours, aiming to determine an athlete's energy, micronutrient, and macronutrient levels. Subsequently, both the recommended and actual values of macro and micronutrients were compared. Table 2 illustrates the suggested nutrient values for adults, and upon scrutinizing the 24-hour recall, significant variations become apparent. While some nutrients align with the recommended values for the athletes, others exceed the upper limits, and certain nutrients fall short of meeting the specified requirements. The data indicates that para-swimmers are not adhering to a well-balanced diet.

Table:2 Energy and Nutrient Intake

Components	Recommended	Received	p-value
Energy(kcal/d)	2693	2301±1112.4	0.252
Carbohydrate(g/d)	130	249±98	0.83
Protein(g/d)	51	49.38±19.2	0.0009
Fat(g/d)	29	113±74	0.001
Calcium(mg/d)	1200	757.7±409	0.82
Zinc(mg/d)	8-10	8±3.1	0.002
Iron(mg/d)	18	17±7	0.042
Magnesium(mg/d)	320-420	491±211	0.2
Sodium(mg/d)	2500	3089±1582	0.2

A nutritional profile assessment reveals variances in nutrient intake compared to recommended levels. It was observed that para-swimmers were deficient in energy and nutrients such as protein, calcium, and iron (Figure 1), while over consuming nutrients like carbohydrates, fat, sodium, and magnesium (Figure 2).

Nutritional assessment tools revealed that many para-swimmers follow a vegetarian diet but lack proper planning, especially in meeting essential protein requirements for muscle repair. Green leafy vegetable intake is low, while milk and dairy are common. Some athletes consume saturated fats, impacting their nutritional balance. Fruit consumption varies, with two members not consuming any in a month. Three swimmers wisely include dry fruits for energy. Para-swimmers are deficient in calcium, zinc, and iron but overconsume fat, sodium, and magnesium. Recommendations include a balanced diet tailored to individual activity levels and disability, emphasizing proper protein intake, managing carbohydrate and fat consumption, increasing fruits and vegetables, and minimizing sugar intake. This thesis aims to improve para-swimmer nutrition, enhance athletic performance, and address unique challenges arising from physical limitations.

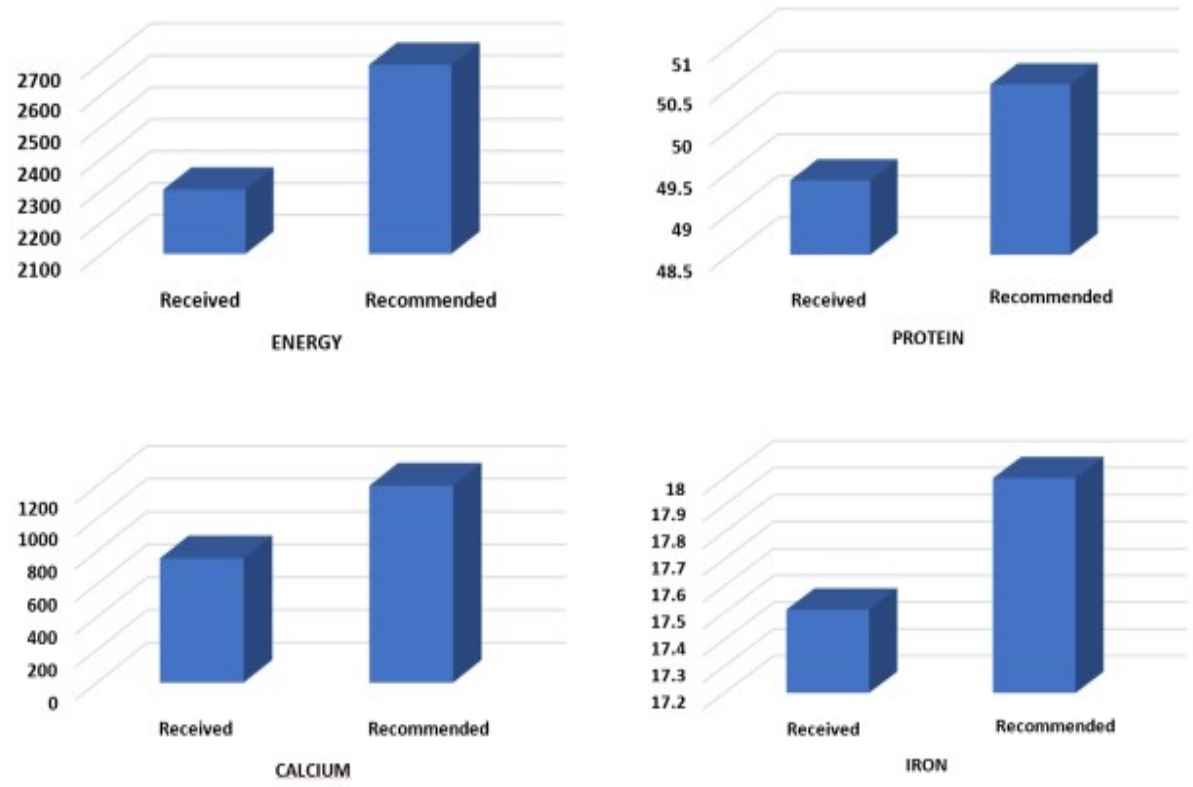

Figure 1. Representation of para-swimmers' received and recommended energy and nutrients such as protein, calcium, and iron.

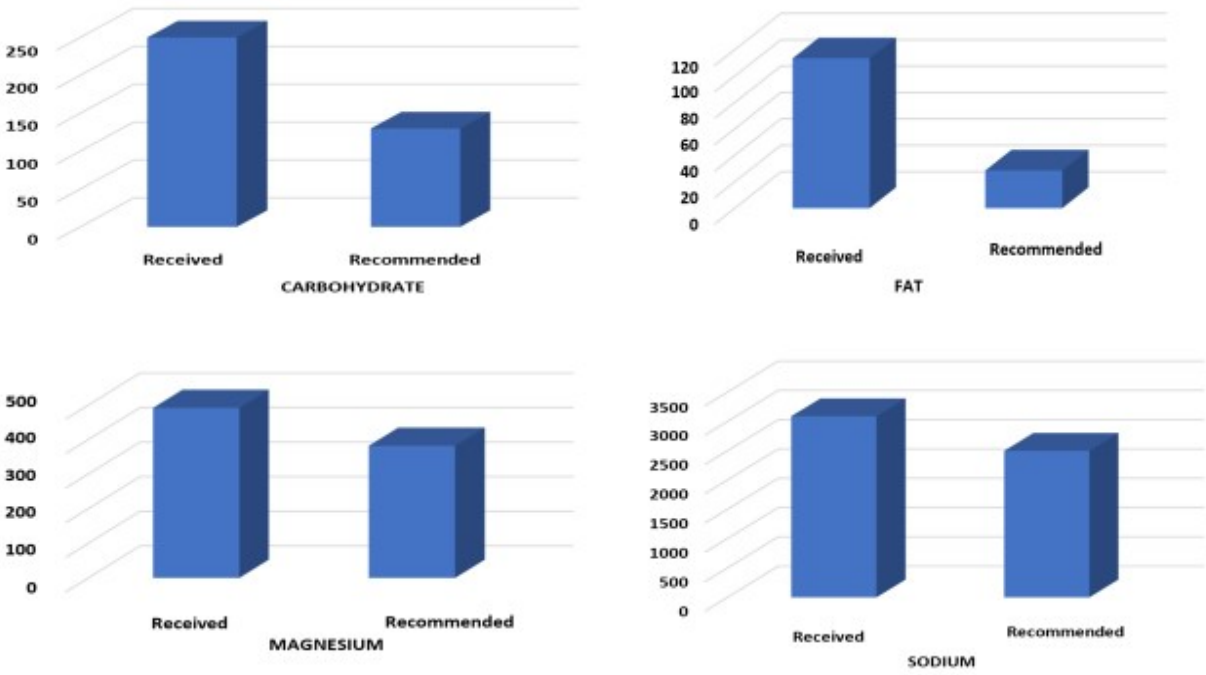

Figure 2. Representation of para-swimmers' received and recommended nutrients such as carbohydrates, fat, magnesium, and sodium.

Conclusion

Nutrition is of paramount importance for para-swimmers, as it plays a critical role in supporting their unique physical demands and optimizing performance. The intensive use of limb muscles during swimming requires adequate protein intake to facilitate muscle repair and recovery, minimizing the risk of injuries. Additionally, proper nutrition addresses specific micronutrient deficiencies, such as calcium, zinc, and iron, ensuring optimal bone health, immune function, and energy metabolism. Para-swimmers need to meet their energy requirements to sustain their activity levels and manage challenges associated with their disabilities. Hydration is crucial, and fruits, with their highwater content, contribute significantly to fluid intake. Weight management is essential for buoyancy and agility in the water, and specialized dietary approaches can address individual disability-related challenges. By minimizing overconsumption of certain nutrients and promoting a well-balanced diet, nutrition enhances endurance, strength, and cognitive function. Ultimately, comprehensive nutritional support not only optimizes athletic performance but also contributes to the overall well-being of para-swimmers, helping them navigate the physical and mental demands of their sport. Based on the observations from the current study, the following nutritional recommendations were made. Para-swimmers should prioritize a well-balanced, nutrient-rich diet, emphasizing lean proteins, whole grains, fruits, vegetables, healthy fats, and dairy or substitutes for optimal nutrition. Caloric needs vary based on activity levels and disability-related factors, requiring athletes to determine an appropriate intake supporting energy expenditure and performance goals. Adequate protein intake from diverse sources is crucial for muscle growth and recovery. Para-swimmers should choose complex carbohydrates from whole grains, fruits, and vegetables to sustain energy, but attention must be paid to sugar consumption to avoid negative impacts. Maintaining a healthy weight is essential, with inclusion of healthful fats from sources like avocados and nuts. Hydration is crucial, especially in regions with high temperatures. A diverse intake of fruits and vegetables ensures essential vitamins and minerals for immune health. Antioxidant-rich foods, like berries and dark leafy greens, aid in reducing oxidative stress. Fiber from whole grains and legumes supports digestion and blood sugar control. Despite daily dairy consumption, calcium deficiency may necessitate fortified foods or supplementation after consultation with a physician due to disabilities. Consistent meal timing, incorporating both protein and carbohydrates, is essential for energy and muscle recovery during exercise. Regular dietary monitoring is crucial for optimal present and future performance, minimizing the risk of deficiencies.

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