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Effect of Curd Intake on the Sports Performance (VO_2 Max) in Resident Female Athletes of Sports Development Authority of Tamilnadu

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Abstract

This study investigated the effect of curd (Indian dahi) supplementation on sports performance, specifically maximal oxygen uptake (VO_2 max), in resident female athletes aged 18–25 years at the Sports Development Authority of Tamil Nadu. Thirty aerobic athletes received 100 ml of curd daily for 45 days while following a standardized diet and training routine. VO_2 max was assessed using the Harvard Step Test at baseline, 15, 30, and 45 days. The results showed a progressive improvement in VO_2 max, with a notable increase after 30 and 45 days of supplementation. The findings suggest that regular curd intake, as a natural probiotic food, may enhance aerobic capacity and endurance in female athletes, highlighting its potential role as a simple and cost-effective nutritional intervention for improving sports performance.

Keywords: Curd, Nutrition, Performance, probiotic

1. Introduction

Nutrition and exercise work together for optimal health. There is a strong relationship between nutrition, physical activity, and long-term health (Lakra & Singh 2008).

The right place of nutrition is a key component of any program that focuses on enhancing fitness, health, and athletic performance. Therefore, it is necessary to perform the exercise properly. Correct nutrition is particularly important for enhancing sports performance, conditioning, rebounding from exercise-induced fatigue, and preventing injury (Aoi et al., 2006).

There is a strong connection between sports performance and nutrition. Sports nutrition, is the application of nutrition principles to improve training, recovery, and performance (Dunford, 2013).

Consumption of food affects overall sports performance and health. A poor- quality diet increases the risk of disease and thus affects an athlete's ability to train and perform at peak performance. However, athletes will experience greater health and increased performance in sports when they eat a balanced diet that supplies the right quantity of energy and minerals. Vitamins, protein supplements, and sports beverages are among the many supplements consumed by young athletes. But frequently, individuals are unaware of their precise nature or mode of operation (Bean, 2010). Therefore probiotics which have a proven effect on improving sports performance may be given as a supplement.

Exercise has a major influence on gut microbiota; physically active people and athletes have higher fecal microbial diversity and microbial genera linked to health. Less research has been done on

the connection between exercise and the composition of the gut microbiota. Frequent exercise raises the amount of soluble carbohydrates (SCFA) in human feces. These SCFAs support intestinal barrier integrity and energy metabolism, which lowers the risk of inflammation. Because lactate from working skeletal muscles reaches the intestinal lumen and feeds some bacteria, the host may also gain from the symbiotic interaction with microbiota during exercise (Díaz-Jiménez, Jara et al).

By definition, probiotic bacteria are live microorganisms found in food that are good for human health. The phrase comes from early studies evaluating the impact of certain yogurt bacteria on the general composition of the human gut microbiota.
Initially, probiotics were employed to modify the gut microbiota (Isolauri, Erika et al., 2004).

Research has demonstrated that taking probiotics can raise aerobic power and VO_2 max in endurance runners, teenage female swimmers, and endurance athletes. In hot conditions, it has been demonstrated that probiotic yogurt containing Lactobacillus delbrueckiis sp. bulgaricus or Streptococcus thermophilus improves VO_2 max and fatigue times. However, no research has been done on the connection between probiotic use and higher VO_2 max and/or tiredness. The differences between the supplemented and non-supplemented athletes might be the result of things like fewer inflammatory cytokines, fewer upper respiratory tract infections (URTs), and training breaks brought on by less muscle injury (Díaz-Jiménez, Jara et al).

TABLE 1
DIFFERENT TYPES OF PROBIOTICS FOODS

PRODUCTS	ORGANISMS	REFERENCE
Ice-cream	Lactobacillus casei, Lactobacillus rhamnosus	Di Criscio et al. 2010
Probiotic goat milk	Bifidobacteriumlongum, Lactobacillus acidophilus	Tsend-Ayusha and Yoon 2013
Yogurt	Lactobacillus acidophilus, Lactobacillus casei, Lactobacillus rhamnosus	Schillinger et al. 2004
Whey Cheese	Bifidobacterium animalis, Lactobacillus casei	Madureira et al. 2011
Cheddar Cheese	Lactobacillus salivarius, Lactobacillus paracasei	Gardiner et al. 1998
Indian Curd	Lactococcus lactis, L. helveticus, L. cremoris, L. casei and L. acidophilus	Kore, K. B., et al. 2012

Physical activity involves any bodily movement caused by muscular contraction that results in the expenditure of energy. Physical fitness is defined as the ability to meet life's demands and still have enough energy to respond to unplanned events. Physical fitness includes five basic components: cardio-respiratory endurance, muscular strength, muscular endurance, flexibility, and body composition. Participation in sports activities improves these fitness components and certain motor skills, which include agility, balance, coordination, power, speed, and reaction time (Greenberget et al., 2004).

The volume of oxygen the athlete breathes in while working out at maximal capacity is an effective way to assess the athlete's level of fitness. The VO2 max has been defined as the maximum millilitres of oxygen that a person can utilize in a minute per kilogram of body weight. Fit people may exercise more vigorously and have greater VO2 max values than less-conditioned people. According to many studies, athletes may enhance their VO2 max by exercising three to five times a week at a level of intensity that causes their heart rate to rise to 65 to 85% of its maximum for at least 20 minutes (Referenced in French & Long 2012).

VO2 max is the most important determinant of performance when large muscle mass is activated during maximal work of a duration ranging from several minutes up to an hour (Havu et al., 1978).

VO2 max is the standard method used to assess cardiovascular or aerobic fitness. The maximum amount of oxygen that an athlete may use during an evaluated exercise test is its definition. The testing procedure is not readily accessible because it requires highly accurate measurements of the athlete's inspired and expired air concentrations for both oxygen and carbon dioxide while the athlete completes the assessed activity test on a step board. When an athlete maintains a steady oxygen intake during an increase in exercise test intensity, they have hit their VO2 max. It is expressed in milliliters/minute (mL/min/kg) or liters/minute (L/min) per kilogram of body weight (LeMond, 2015).

The aerobic threshold, the point at which the anaerobic pathway starts to operate, is around 65 per cent of the maximum heart rate. This is approximately 40 beats lower than the anaerobic threshold. The aerobic thresholds of untrained males range from 35 to 65 per cent VO2 max (Mackenzie, 1997). The maximal oxygen consumption establishes the upper limit of maximal energy production through oxidative phosphorylation and is generally considered to be a primary determinant of endurance exercise performance among young endurance–trained athletes (Tanaka et al., 2008).

VO2 max is assessed using the Harvard step test. This method was initially developed by Lucien Brouha in the Harvard Fatigue Laboratories during World War II as a means of assessing cardio-respiratory endurance. It is based on the recovery of heart rates after a specified workload that lasts for five minutes or until exhaustion (Brouha et al., 1943).

Need for the study:

Studying the effect of curd intake on sports performance, specifically focusing on VO2 max in resident female athletes of the Sports Development Authority of Tamil Nadu, can provide valuable insights into the relationship between nutrition and athletic performance.

Scope:

Curd is a rich source of protein, essential for muscle repair and athletic performance. It is rich in calcium, vital for maintaining strong bones. Yogurt contains probiotics, beneficial bacteria for gut health. Its high water content contributes to hydration and electrolytes, such as potassium, essential for fluid balance. Carbohydrates in yogurt provide a quick, easily digestible energy source, beneficial for athletes engaging in prolonged exercise. The study investigates the link between curd consumption and sports performance in female athletes. It uses a baseline VO2 Max Assessment, a specific curd intake protocol, and data analysis.

REVIEW OF LITERATURE

NUTRITION AND SPORTS

The majority of people tend to either overemphasize or underemphasize the importance of nutrition to exercise performance, making the association between physical activity and nutrition to be misinterpreted. More precisely, to train efficiently and benefit from training stimulus, a healthy diet is required (Krogh and Lindhard, 1920).

The human body has created systems for energy storage. The body gets out of the need to constantly replenish its energy reserves because of this storage. Foods high in macronutrients have chemical connections that are high in energy. Following digestion and absorption, energy is retained as chemical bonds in skeletal muscle (protein), glycogen (carbohydrate), and triglycerides (fat). Work is done using this chemical body's stored energy (Brawn and Benjamin, 2008).

NUTRITION AND ATHLETIC PERFORMANCE

Athletic performance could be increased through proper nutrition. The most effective way to stay healthy is to have a physically active routine, engage in regular physical activity, and follow a nutritious diet.

Maintaining a nutritious diet and consuming enough water can help an athlete to have the needed stamina to win a race or just participate in recreational sports or activities. When the recommended diet is deficient, athletes are more likely to feel fatigued and perform badly during sports. These are the nutrition required

- Calories
- Carbohydrate
- Fluids
- Iron, vitamins, and other minerals
- Protein

The diet that is recommended for athletes is similar to that of any healthy individual. But the quantity of each dietary category that an athlete requires may vary depending on:

- The form of sport;
- The level of training;
- The period spent engaging in the exercise or activity

Carbohydrate

Carbohydrates in the diet are essential. They are essential to supplying energy when working out. Glycogen, or stored carbohydrates, is mostly found in the liver and muscles of the body. Foods such as rice, pasta, bagels, and whole-grain breads include complex carbohydrates. They are low in fat and offer energy, vitamins, minerals, and fiber. Simple sugars, which include soft drinks, jams, jellies, and candies, are high in calories but low in fat and lack vitamins, and minerals. Simple sugars are found in jams, jellies, soft drinks, and other nutrition. The overall amount of carbohydrates ingested daily is what counts most. Carbohydrates should make up a bit over half of the calories. Carbohydrates are a source of energy and are expected to be higher in curd.

Proteins

Protein is essential for the healing of the tissues and muscular development. The human body can utilize protein for energy as well, but only after using up its stored reserves of glycogen or carbohydrates. Researchers have shown that the common belief among athletes that a high-protein diet is necessary to promote muscle growth is inaccurate. The idea that eating a lot of protein can help you gain muscle mass is similarly inaccurate. Exercise and strength training are the only ways to alter muscle. It just takes a small amount of additional protein for bodybuilders and athletes to boost muscle growth. It is easy for athletes to fulfill this additional demand by increasing their overall calorie intake (taking in more food). Proteins are a very significant class of naturally occurring substances. They carry out a wide range of tasks in living things. The Indian Standard does not currently specify the amount of protein that curd must have.

Water and fluids

For athletes, water is the most crucial—yet often neglected—nutrient. The body needs fluids, especially water, to be hydrated and at the proper temperature. In a single hour, the body may eliminate several liters of sweating (Bonci, 2009). Whey, which comprises the remaining milk proteins, sugar, and soluble milk salts, is left over after the fat and casein are removed from the milk.

PHYSICAL ACTIVITY

Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. Exercise is a subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective. Physical activity includes exercise as well as other activities that involve bodily movement and are done as part of playing, working, active transportation, house chores, and recreational activities (WHO, 2011).

BENEFITS OF PHYSICAL ACTIVITY

Exercise has numerous benefits which go further than aiding people to lose weight. Daily exercise has been proven to lower the risk of several conditions and medical conditions as well as improve overall quality of life. Engaging in regular physical activity may protect against several health issues.

Obesity, diabetes, and excessive blood lipid levels can all be managed with exercise. In middle-aged and older populations, there is a dose-response relationship between the quantity of exercise done, ranging from around 700 to 2000 kcal of energy expenditure per week. The sedentary who start a modest level of activity has the most chance of reducing death (Blaie et al., 1995).

HEALTH BENEFITS OF EXERCISE

Engaging in regular moderate physical activity and exercise can enhance the quality of life and lower the risk of coronary heart disease, hypertension, some malignancies, and type 2 diabetes in individuals of all ages. Regular exercise also improves mental health and supports normal musculoskeletal function for the whole of a person's life. Engaging in regular physical exercise is a goal that may be achieved on the road to better health (Centers for Disease Control and Prevention [CDC] 2007).

A significant obstacle for several personal fitness trainers (PFTs) and other health and fitness experts is devising novel approaches to inspire individuals to enhance their overall health by regularly engaging in physical activity and exercise. As demonstrated, modest physical exercise may have a substantial positive impact on one's health (Swain and Franklin 2006).

1. Heart-related conditions

Cardiovascular disease is the main health-related cause of death in the United States for both men and women. Long-term engagement in cardiovascular exercise can lead to significant improvements in cardiovascular health. Men's risk of CVD is 50% lower when they have higher levels of cardiovascular fitness. Myers et al. showed that a 20% decrease in male mortality is linked to increasing physical activity to a weekly total of at least 1,000 kilocalories. It is important to remember that "not smoking, being physically active, eating a heart-healthy diet, staying reasonably lean, and avoiding stress and depression are the major components of an effective cardiovascular disease prevention programme."Cardiovascular disease is a multifactorial process (Haskell 2003).

2. Insulin Sensitivity, Carbohydrate Metabolism, and Diabetes

Frequent aerobic exercise improves glucose metabolism and insulin sensitivity, allowing the body's cells to carry glucose into the cells of the liver, muscles, and adipose tissue more effectively. 170 million people worldwide suffer from diabetes, which has reached endemic proportions (Stumvoll, Goldstein, and van Haeften 2005). One unfavorable health effect of inactivity is the deterioration of the body's insulin-regulating systems. The development of non-insulin-dependent diabetes mellitus is characterized by elevated insulin and blood glucose levels. The body's blood sugar levels rise when insulin function begins to deteriorate, which ultimately causes "prediabetes" and type 2 diabetes to appear. Obesity and inactivity are major contributing factors to the rising prevalence of diabetes in both adults and children.

3. Hypertension

Frequent aerobic exercise may guard against the rise in blood pressure that is often associated with aging, even if it typically has little effect on the blood pressure of normotensive people (Fagard 2001). Elevated blood pressure is a serious health issue. Hypertension, specifically elevated systolic and diastolic blood pressure, is linked to an increased risk of developing heart disease, stroke, congestive heart failure, and renal failure. When blood pressure reaches 140/90 millimeters of mercury (mm Hg), the risk of having these disorders increases onefold (Bouchard and Despres 1995). Due to a lack of data, the evidence supporting the effectiveness of higher-intensity exercise in controlling hypertension is currently contradictory. Results (in hypertensive men and women) showed an average decrease in systolic blood pressure of 3.84 mm Hg and diastolic blood pressure of 2.58 mm Hg in a recent meta-analysis of 54 clinical aerobic exercise intervention studies (Whelton et al. 2002).

4. Lipid profile

Long-term studies of people with high blood cholesterol and the risk of coronary heart disease have rather thoroughly established the relationship between cholesterol and coronary heart disease. Increases in high-density lipoprotein cholesterol, or "good cholesterol," are independently linked to a decreased risk of coronary heart disease (Neiman 2003). Furthermore, it is commonly known that a sedentary lifestyle is strongly linked to the development of coronary heart disease as well as unfavorable elevations in blood fat and cholesterol levels; physical exercise is crucial in reducing these health

concerns.

5. Stroke

Engaging in physical activity can significantly reduce the risk of stroke in both men and women. When compared to those who exercise little, those who participate in moderate to high levels of physical activity have a decreased risk of stroke occurrence. According to statistical data, those who engage in moderate physical activity have a 20% lower risk of stroke, whereas highly active individuals have a 27% lower risk. To lower the risk of stroke or recurrent stroke, increasing aerobic exercise is advised for cardiovascular health, and strength training is advised for mobility and balance (Sacco et al. 2006).

6. Cancers of the colon, breast, lung, and multiple myeloma

Exercise and physical activity are linked to a decreased risk of breast cancer in women and colon cancer in males. According to Lee (2003), physical exercise at a moderate to high intensity offers a higher level of protection than activity at a lower intensity. The author points out that compared to those who are not physically active, men and women who are physically active have a 30%–40% lower relative risk of colon cancer. It appears that for this risk reduction, 30 to 60 minutes of moderate to intense activity per day are required, and even lower risk is associated with higher levels of exercise. Furthermore, women who engage in physical activity have a 20%–40% lower relative risk of breast cancer when compared to women who do not. Also, it seems that to produce this degree of risk reduction, 30 to 60 minutes of moderate-to-intense exercise each day are required. While lung cancer is very uncommon among nonsmokers, it seems that physically active people may also have a decreased chance of developing the disease, however, more study is required in this area (Lee 2003).

7. Osteoporosis

Exercises that promote bone formation must address load variety and specificity, as well as progressive stress. Exercises that directly apply force to a particular area of the skeleton are referred to as specificity of load exercises. Resistance training and weight- bearing aerobic exercise may offer the necessary stimulus for bone formation in cases of osteoporosis, a degenerative disease marked by a loss of bone mineral density that increases the risk of bone fractures and other health issues (Kohrt et al. 2004). Gradual overload is required to prevent the bone and related connective tissue from growing over the critical point, which might endanger them. Exercises like lunges and squats, which channel forces through the axial skeleton and enable higher weights to be applied, should be a part of full-body workout regimens to preserve and promote bone formation. Furthermore, there is evidence to suggest that age-related bone loss can be prevented with modest weight-bearing activities like frequent, brisk walking. Increased physical activity and harder relative effort levels are more beneficial in building bone density. To maintain bone health as an adult, Kohrt and colleagues advise engaging in weight-bearing endurance exercises three times a week and resistance training two to three times a week for a total of thirty to sixty minutes of activity each day.

8. Achilles Tendinopathy and Sarcopenia

Enhancing movement skills and improving musculoskeletal health need a combination of muscle growth, strength, power, and endurance (Marcell 2003). While aging is a significant factor in the decline

of these musculoskeletal health components, the Marcell research suggests that a decrease in physical activity has a major role as well.

The age-related decrease in strength and muscular mass is known as sarcopenia (Marcell 2003). Marcell continues, "After age 50, the rate of muscle loss is fairly constant, ranging from 1% to 2% annually." He points out that a decrease in muscular strength is directly correlated with a decrease in independence, which increases the risk of falls, fractures, and nursing home admissions. Furthermore, as a result of the loss of muscle mass, there is a reduction in the maximal oxygen consumption and metabolic rate.

Elderly people may be able to carry out everyday tasks more efficiently and with less effort if their musculoskeletal health has improved (American College of Sports Medicine, 2006). According to the American College of Sports Medicine, 2006 resistance training guidelines, older adults should complete at least one set of eight to ten exercises that target all major muscle groups. For the energetic older exerciser, each set should comprise 10 to 15 repetitions at a relatively difficult intensity. Multijoint exercises on machines are advised for the prevention of sarcopenia because they may be easier to manage the workout range of motion and need less skill.

9. Exercise and obesity

In the United States, obesity has reached epidemic proportions, with 31% of persons obese and over 65% overweight (American College of Sports Medicine, 2006). A higher risk of hypertension, osteoarthritis, abnormal cholesterol and triglyceride levels, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, sleep apnea, respiratory issues, and certain cancers (endometrial, breast, and colon) is linked to being overweight or obese, according to the Center of Disease Control.

The best method of losing weight combines calorie restriction, physical training, and dedicated aerobic exercise with a reliable behavioral change delivery system. The best results for weight reduction come from increasing cardiovascular exercise to 200– 300 minutes of moderate-intensity activity spread over 5–7 days per week about 2,000 kcal per week of exercise (American College of Sports Medicine, 2006). Research on circuit training and resistance training has revealed significant alterations in body composition (Marx et al. 2001). In terms of body composition, one of the notable advantages of resistance exercise is its ability to preserve or increase fat-free body mass while promoting the reduction of fat body weight in the context of a progressive overload resistance training programme.

10. Arthritis

Over 100 rheumatic disorders are included under the general term "arthritis." The two most common kinds of arthritis are rheumatoid arthritis, which is an inflammatory illness affecting many joints, and osteoarthritis, a degenerative joint disease (Maes and Kravitz 2004). Arthritis is a medical condition that can afflict individuals of any age, gender, or ethnicity. It is often characterized by stiffness, pain, and loss of joint function. Individuals' freedom may be taken away, endangering their bodily, psychological, social, and financial well-being. Exercise is a typical arthritis therapy recommended by doctors. Regular exercise enhances mood, muscular strength, joint mobility, aerobic capacity, and functional ability without appearing to worsen joint disease or symptoms (Finckh, Iversen, and Liang 2003). For some persons, exercise has been shown to have a pain-relieving impact comparable to that of pharmaceutical

therapy. When it comes to creating an exercise program for patients who have severe joint degeneration, particularly in their weight-bearing joints, Finckh and colleagues advise exercising cautiously. The authors further note that swimming, aquatic walking and bicycling, and other aquatic exercises are significantly safer for the weight-bearing joints and should be substituted for high-impact activity, which is contraindicated in many cases of arthritis. According to Maes and Kravitz (2004), exercise programming for clients with arthritis should prioritize gradually improving aerobic conditioning, increasingly overloading resistance activity, and steadily increasing joint stability and flexibility (Maes and Kravitz 2004).

11. Stress

Over the past ten years, an increasing amount of research has confirmed that exercise and physical activity can enhance psychological well-being (Dubbert 2002). It is crucial to note that the majority of the research discussed here is correlational, meaning that rather than focusing on causal linkages, the scientists examined the associations that existed between mental health characteristics and exercise. Research that has been published indicates that those who are more fit can handle stress better than less fit people (Hassmen, Koivula, and Uutela 2000).

According to the findings, there appears to be an inverse association between stress levels and physical fitness. Cardiovascular activity seems to be the type of exercise that reduces stress the most. Research characterizes exercise's function in stress management as a preventative rather than a therapeutic measure. According to the research, the most effective way to reduce stress is to engage in three sessions of moderate-intensity aerobic exercise each week for a maximum of twelve weeks. These sessions should last more than twenty minutes each. Though the precise processes elucidating the reduced stress levels resulting from aerobic exercise remain uncertain now, potential hypotheses encompass the participation of physiological, biochemical, and psychological elements (Callaghan 2004).

CARDIOVASCULAR ENDURANCE

The potential of the lungs, heart, and blood arteries to supply oxygen to working muscles and tissues, as well as the capacity of those tissues and muscles to make use of that oxygen, is known as cardiovascular endurance. Although endurance can also refer to a muscle's capacity to perform repeated tasks without becoming fatigued, it is also one of the five elements of physical fitness. Cardiovascular endurance is also commonly referred to as cardio-respiratory endurance, cardiovascular fitness, aerobic capacity, and aerobic fitness, or it can be more broadly termed "endurance" (Matt, 2008).

BENEFITS OF AEROBIC TRAINING

- An improved maximum utilization of O_2 (VO_2 MAX)
- A rise in the capacity of the blood to transport oxygen
- An increase in cardiac muscle strength and a fall in resting heart rate (RHR)
- A lower heart rate for the specific workload.
- An expansion of the mitochondria's size and quantity.
- Reduce blood cholesterol and blood pressure.

- The capacity to bounce back quickly after exercise.
- A rise in enzymes that burn fat (Hoeger and Hoeger, 2009)

AEROBIC CAPACITY

Every athlete on the field needs to have an exceptional aerobic capacity due to new laws and fierce competition. Sports competition represents a standard assessment of an athlete's physical powers. Cardio-pulmonary capacity and the ability of functional muscles to create ATP in the presence of oxygen are two examples of systems whose functional capabilities are directly correlated with aerobic capacity. These systems are all involved in the supply, transit, and energetic oxygen transformation. Even if a training cycle of up to 10% can condition an improvement in VO_2 max, it is still insufficient to fulfil both European and global criteria after the age of 22.

Inadequate aerobic capacity makes it unable to sustain a high degree of aerobic activity, which in turn prevents athletes from performing to their full potential in several sports because it causes gradual tiredness, particularly in the last 15 minutes of a game. A high degree of aerobic capacity is necessary to succeed in many sports; for this reason, VO_2max measurement is particularly significant as it is a crucial factor in professional sports and a reflection of an athlete's physical potential (Rankovic, Goran et al., 2010)

MAXIMAL O_2 UPTAKE (VO_2 MAX)

Maximal oxygen uptake (VO_2 max), is the maximal amount of oxygen capable of being transported to and consumed by the working muscles. It can be used as a measure of aerobic fitness. At rest, the body uses about 3.5 milliliters of oxygen per kilogram of body weight per minute (0.5 mL/kg/min) to sustain life. Measures of VO_2 max have been recorded as high as 92 mL/Kg/min - scores like this are characteristic of elite endurance athletes. A low VO_2 max, indicating poor fitness in a middle-aged man, would be around 26 mL/Kg/min. As physical fitness and the capacity of the heart improve with training, oxygen uptake would improve significantly (Egger et al., 1999). VO_2 max or the ability of the human body to use or consume oxygen for aerobic metabolism during exercise is an important predictor of athletic performance in endurance activities (National Strength and Conditioning Association, 2008).

Maximum ventilatory oxygen uptake drops 5% to 15% per decade between the ages of 20 and 80, and a lifetime of dynamic exercise maintains an individual's ventilatory oxygen uptake at a level higher than that expected for any given age. The rate of decline in oxygen uptake is directly related to the maintenance of physical activity levels, emphasizing the importance of physical activity (Jackson et al., 1995).

Another measure of aerobic capacity is the Metabolic Equivalent, short for a basic metabolic unit. One MET is the amount of oxygen used by the body at rest (i.e. around 3.5mL/Kg/min), and maximum oxygen uptake is expressed in terms of multiples of this unit or max Metabolic Equivalents. Metabolic Equivalent scores can be equated with VO_2 max scores by multiplying Metabolic Equivalents by 10. In training for cardiovascular improvement, exercises at a predetermined MIT level (generally 60-80% of max Metabolic Equivalents) are often used to ensure sufficient individual effort to establish a training effect (Egger et al., 1999).

FACTORS AFFECTING VO2 MAX

Exercise mode:

Variations in VO2 max during different modes of exercise reflect the quantity of muscle mass activated. In experiments that measured VO2 max on the same subjects during diverse exercises, treadmill exercise produced the highest values.

Hereditary:

Genetic make-up, which can account for as much as 70% of a person's VO2 max is dictated by heart size and strength and muscle fiber type. Heredity alone accounts for up to 93% of the observed differences in VO2 max. Current estimates of the genetic effect ascribe about 20%-30% for VO2 max, 50% for maximum heart rate, and 70% for physical working capacity.

Training state

Maximal oxygen uptake must be evaluated according to the person's state of training at the time of measurement. Aerobic capacity with training improves between 6% and 20%, although increases have been reported as high as 50% above pre-training levels.

Age:

Changes in VO2 max relate to chronological age, VO2 max naturally increases with growth up to about 20-25 years and then begins to decline at a rate of about 1% per year.

Gender:

Females on average have 15-30% lower aerobic capacity than males of a similar age and training status. The apparent gender difference in VO2 max has been attributed to differences in body composition and the blood's hemoglobin concentration. Untrained young adult women possess about 25% body fat, whereas the corresponding value for men averages 15%. Thus, the male generates more total aerobic energy simply because he possesses a relatively large muscle mass and less fat than the female.

Body composition:

Differences in body mass explain roughly 70% of the differences in VO2 max among individuals. Thus, meaningful comparison of VO2 max becomes difficult among individuals who differ in body size or body composition

The amount and intensity of exercise or activity regularly performed, can alter VO2 max usually by 10-20%, in some cases of very sedentary individuals. (Buckley et al., 1999).

Other factors which can affect VO2 max include

- The type of activity performed
- The number of large muscle groups being used
- An individual's state of physical health and environmental factors including altitude and

temperature
(Mc Ardle et al., 2006)

FACTORS CONTROLLING VO2 MAX

The maximum amount of oxygen inhaled during maximal effort is measured by a VO2 max test. One method to assess the intensity of exercise is by evaluating oxygen uptake. Indications of endurance for sports like long-distance running, triathlons, and cross-country skiing include VO2 max. It can restrict or improve performance even with the best training.

Gender

Due to their larger bodies than women, men's hearts are bigger and can pump more blood. To breathe in more oxygen, they also have bigger lungs.

Age

In general, younger people have higher VO2 max than older persons. The highest VO2 MAX in a person's life is reached by both males and females between the ages of 18 and 25, after which it gradually drops. The body hasn't fully formed until about the age of 18. VO2 max starts to decrease at about age 25, and it does so at a pace of roughly 1% per year.

Genetics

The form of heart muscle fibers, the size of the body, including the heart and lungs, and the heart's pumping power are all influenced by heredity. Between 20 and 30 percent of the VO2 max is attributed to heredity, according to Cerritos College in California.

Altitude

At higher elevations, less oxygen is available due to lower air pressure. The VO2 max is lowered at altitude because of a reduction in arterial blood oxygen pressure.

Size

The chance of a higher VO2 max increases with body size. Larger individuals can hold more oxygen since their hearts and lungs are bigger.

Temperature

The temperature from the outside air can have an impact on VO2 max; higher temperatures allow for quicker oxygen consumption.

Exercise mode

Variations in VO2 MAX throughout various exercise techniques are indicators of the kind of active muscle mass. When the same patients were measured for VO2 max during different types of exercise, treadmill activity had the highest values (Warpeha, 2003).

Means of expressing VO2 max:

VO2 max is usually expressed in one of the two ways:

- In absolute terms as liters per minute (liters.min^{-1})
- Relative to a person's body mass as milliliters per kilogram per minute (ml.kg^{-1}.min^{-1}) (Buckley et al., 1999)

Heart rate

While the average pulse rate of a sedentary man is around 72 beats per minute and of a woman around 80 beats per minute, these rates are often significantly less in trained athletes. Heart rate responses to standard workloads have, over the years, been used as an indication of changes in physical fitness. With training that raises the heart rate (HR) above a standard workload, the working HR will decrease, enabling a greater workload to be carried out with the same effort (Egger et al., 1999).

HARVARD STEP TEST

Harvard step test was performed on a 50-cm bench for males and 40 cm for females, and measured for 5 min at a metronome speed of 120 bpm. After completing the Harvard Step test for 5 minutes, heart rate was measured between 1 to 1.5 minutes, between 2 to 2.5 minutes, and between 3 to 3.5 minutes during the recovery period on the chair (Kim, Dong-Hwan et al)

Test for implementation

a. Participants take a straight stance in front of the Harvard bench.
b. For five minutes, participants must move up and down the bench at a rhythm determined by the metronome—120 times per minute.
c. After receiving the start signal (the stopwatch is turned on), participants elevate their right foot on the bench, raise their left leg next to it, and then drop their right leg and then their left foot. And so on, in time with the metronome's beat, up and down.
d. The subject's torso must stay straight and their feet must rest on the bench during the exam.
e. The measurement is halted (the stopwatch is stopped) and the time is recorded if the participant has not yet reached the five-minute mark.
f. The participants sat down as soon as they stopped.

FERMENTED FOODS AND THEIR IMPORTANCE

Foods that have undergone microorganism or enzyme treatment to produce desired biochemical alterations that can significantly alter the diet are known as fermented foods. To the microbiologist, on the other hand, "fermentation" refers to a kind of microbial metabolism in an organic medium that produces energy. Many of the foods, like chocolate, coffee, wine, and beer, as well as the most fundamental essentials, like bread and cheese, are products of fermentation. Fermentation improves the nutritional value and ease of digestion of food. Fermented foods that are live and unpasteurized also introduce good bacteria into our digestive tracts, where they work in harmony to help in the breakdown of food and facilitate digestion (Katz 2003).

Foods that require fermentation are those that have been significantly altered by the activity of microorganisms or enzymes, resulting in desired biochemical changes. However, the word "fermentation" refers to a type of incompletely oxidized organic substrate—typically a carbohydrate—that produces energy through microbial metabolism in the context of microbiology (Adams, 1990).

Humans have been aware of and engaged in fermentation since prehistoric times when it is believed that the underlying scientific principles were recognized. The scientific study of fermentation microbiology and, by extension, biotechnology did not start until the 1850s, when Louis Pasteur was able to separate two distinct forms of amyl alcohol, one of which was optically active and the other not. Pasteur's investigation into fermentation began with this finding. After publishing the findings of his research in 1857, Pasteur concluded that fermentation has more to do with the structural integrity and life of yeast cells than it does with their decomposition and death. The field of fermentation microbiology and biotechnology underwent a second phase of development in 1877 when Moritz Traube put forth the theory that substances resembling proteins catalyze chemical reactions, including fermentation. According to Traube, these substances remain unaltered after the reactions. According to Allman, 2006, fermentation is a series of processes that result in the synthesis of highly reduced product alcohol and highly oxidized product CO2 as oxygen is transported from one portion of the sugar molecule to another (Allman, 2006).

PROBIOTICS

According to the Food and Agricultural Organization of the United Nations and the World Health Organization, probiotics are defined as "living microorganisms, which when administered in adequate amounts confer health benefits on the host (Food and Agriculture Organization of the United Nations et al., 2006).

Probiotics were first brought to the scientific community by Nobel laureate Elie Metchnikoff. He released a summary of research showing that Bulgarians lived longer because they consumed fermented milk products that contained live lactobacilli (Metchnikoff and Mitchell, 1907). This finding raised the possibility that some microorganisms may be healthy for humans if consumed. Probiotics have been sold and consumed extensively since that time, mostly as functional foods or nutritional supplements. Probiotics are mediated by a variety of mechanisms, including control of the immune system, suppression of pathogens, modification of intestinal microbial populations, promotion of epithelial cell proliferation and differentiation, and fortification of the intestinal barrier (Thomas and Versalovic, 2010).

Probiotics may be useful in reducing the symptoms of certain food allergies, such as those related to milk protein. In addition, the diet of infants on a hydrolyzed whey formula reduced the symptoms of atopic dermatitis, possibly by the breakdown of these proteins into smaller peptides and amino acids (Majamaa and Isolauri 1997).

HISTORY OF CURD

The oldest known traditional technique of creating and preserving food, fermentation offers a wide range of tastes, scents, and textures that enhance the human diet. Foods that have undergone this process can also improve the nutritional content and medicinal value, as well as improve digestibility. Fermented milk has been a part of human diets since the Vedic era. Traditionally fermented dairy

products like dahi (curd), buttermilk (chass), and sweetened yogurt (lassi) are staples in every Indian subcontinent home. "Ayurveda" is a traditional Indian medicinal system that has been used for thousands of years. It uses hundreds of animal products, thousands of plant species, and almost 100 minerals to treat a wide range of illnesses. According to the WHO, traditional medicines are the main source of healthcare for nations in Africa, Asia, and Latin America. Since ancient times, dahi has been suggested in Ayurveda medicine as a remedy for diarrhea and other acute and chronic gastrointestinal issues. Traditional fermented milk products, such as dahi or curd, have lactic acid bacteria that are promising and have been linked to probiotic benefits for consumers' health (Pattanaik et al., 2011)

CURD

Curd is considered to be a complete, natural meal. It is a white milk product that was produced as a result of bacterial activity. Because fresh curd is high in nutrients and probiotic microorganisms, eating it every day can help avoid some ailments. It is a functional diet that increases immunity, both acquired and natural, and strengthens endurance. Curd is the best source of probiotics and provides our digestive tract with good and healthy microorganisms. The milk of cows or buffaloes belonging to the Bovidae family is used to make curd. Because buffalo milk has more total solids (16–19%) than cow milk (12%), the curd made from buffalo milk is denser (pragan et al., 2019).

The bacteria that contribute to the creation of curd are Streptococcus lactis, Streptococcus thermophilus, Lactobacillus bulgaricus, Lactobacillus acidophilus, Lactobacillus helveticus, and Lactobacillus cremoris. Lactic acid fermentation is how curd is created. Thus, a small amount of fermented curd is utilized as a base ingredient (Madhu et al., 2013)

OTHER USES OF CURD

1. Acquired Immune Deficiency Syndrome (AIDS):

The human immunodeficiency virus's (HIV) infectivity is greatly decreased by curd. The Lactobacillus rhamnosus GR-1 found in curd has been demonstrated to significantly boost the immune systems of AIDS patients. According to Irvine et al. (2010), HIV-positive individuals experience a rapid decline in CD4 lymphocytes, which is linked to increased intestinal permeability. They also experience altered gastrointestinal functions, altered gut microbiota profiles, increased concentrations of pathogens like Candida albicans and Pseudomonas aeruginosa, and decreased concentrations of lactobacilli and bifidobacteria. The therapy of HIV can greatly benefit from the vitamins B, C, E, folic acid, selenium, and whey protein found in curd. Consequently, curd offers a natural, affordable, and safe method of forming a barrier against microbial diseases (Hummelen et al., 2010).

2. Cancer

The malignancies of the digestive system, stomach, esophagus, and colon are the third most common cancers in the world, accounting for more than a million cases annually. Patients recover more quickly when they eat well before, during, and after cancer therapy. Consuming curd, which has the ideal proportion of lipids, proteins, carbs, vitamins, and minerals, can aid in the battle against cancer. Probiotic-containing curd suppresses the growth and development of tumors. According to a study, colon cancer patients' feces had reduced amounts of soluble bile acids after receiving fermented curd

fermented by Lactobacillus acidophilus for six weeks. This was the cause of the cytotoxic impact on the colon epithelium (Correa and Piazuelo, 2012).

3. Diabetes and improving lipid profile

An impaired antioxidant defense system and increased generation of free radicals are linked to type 2 diabetes mellitus. By chelating metal ions, scavenging reactive oxygen species, inhibiting enzymes, and preventing ascorbate autoxidation, probiotics strengthen our anti-oxidant defense mechanism. Animal studies have established that Lactobacillus acidophilus and Lactobacillus casei have an antidiabetic effect via attenuating oxidative stress (Farvin et al., 2010).

Consuming curd was shown to reduce total cholesterol (TC) by 4.5% and LDL-C by 7.5% when compared to the control group in a study (Farvin et al., 2010).

4. Insomnia

When someone is unable to fall asleep at night, it is called insomnia. A few of the symptoms are feeling restless in the morning, waking up in the middle of the night, exhaustion, anger, anxiety, sadness, headaches, and stomach issues. Eating yogurt or curd before bed can help cure insomnia at home. The main amino acid that our body uses to make the hormones serotonin and melatonin, which are important in promoting relaxation and sleep, is tryptophan. Research has demonstrated that taking melatonin, magnesium, and zinc supplements every day for eight weeks, one hour before bed, improves the quality of sleep (Katri et al., 2012).

5. Liver diseases

The intestines may contain bacteria that produce endotoxins, according to several in vivo investigations conducted on both humans and animals. By altering the immunological and digestive systems, probiotic administration reduces the symptoms of ALD. The expansion of gut microbiota, excessive bacterial lipopolysaccharide production, and chemicals that induce inflammation are the causes of non-alcoholic fatty liver disease (NAFLD). The medications polymixin B and metronidazole are utilized to lower the overabundance of microorganisms in NAFLD patients (Imani et al., 2013).

POTENTIAL HEALTH BENEFITS OF PROBIOTICS FOR ATHLETES

Effect of Probiotics on the Immune System

In 2019, Vaisberg et al. found that Lactobacillus casei Shirota (LcS) can modulate the immune response, inflammatory, and mucosal upper respiratory tract, providing protective effects. Similar results were observed in athletes, where probiotic yogurt containing 4 × 1010 CFU/mL-Lactobacillus Acidophilus SPP, Lactobacillus Delbrueckii Bulgaricus, Bifidobacterium Bifidum, and Streptococcus Salivarus Thermnophilus reduced the number of episodes of URTIs in adolescent female swimmers. In 2014, Haywood et al. found a reduction in the duration and amount of URTI symptoms in elite rugby players (Haywood et al., 2014)

Effect of Probiotics on the Gastrointestinal System

Long-distance and endurance runners are more likely to experience gastrointestinal problems due

to the redistribution of blood flow to active muscles and skin, reducing irrigation, and causing abdominal pain. This can also damage intestinal mucosa, increase the risk of permeability, and blood loss, and alter the GI protective microbiota. The continuous movement of the intestine, fluid intake, and GI system malfunctions can affect nutrient assimilation, leading to decreased performance due to a lack of energy and nutrients (De Oliveira et al., 2014).

Effect of Probiotics on Oxidative Stress

Long-distance and endurance sports can increase oxidative stress, leading to increased inflammatory and anti-inflammatory cytokines. Probiotics are used to alleviate these effects, affecting immune system performance. Studies have shown that Lactobacillus plantarum PS128 supplementation can decrease oxidative stress in triathletes. Genetic predisposition to greater inflammatory profiles can affect viral infection duration and severity. University athletes who received Lactobacillus gasseri OLL2809 supplementation showed improved defense against infection and elevated mood. Genetic inheritance also plays a role in these effects. Therefore, genetics play a crucial role in addressing the health risks associated with prolonged exercise (Toshihiro et al., 2013).

OTHER BENEFITS

The benefits of probiotics in endurance athletes are preventing mental illnesses like depression and anxiety that can affect performance. While some studies have been published, further research is needed due to low to medium-scientific-quality evidence. There are no studies on the effects of probiotic use on the hormonal system, nervous system, or intestinal metabolites (Nikolova et al., 2019)

GUT MICROBIOTA AND PHYSICAL PERFORMANCE

Exercise and the composition of the gut microbiota appear to be correlated in both directions. Human exercise intervention research has shown that consistent physical activity alters the makeup of gut microbes. Additionally, accumulating data from research on animals indicates that the gut microbiota is crucial to the host's ability to function physically. An athlete may benefit metabolically during high-intensity training and recuperation if their gut microbiota's makeup and metabolic activity help with food digestion and enhance the production of energy Non-digestible carbohydrates are fermented in the stomach by bacteria, mainly producing the short-chain fatty acids such as butyrate, propionate, and acetate. Human fecal short-chain fatty acids (SCFA) contents have been linked to training and regular exercise, and in animal research, certain short-chain fatty acids (SCFAs) have been linked to enhanced physical performance. The majority of short-chain fatty acids enter the body through the digestive system and aid in the metabolism of the host's energy. The colon's epithelial cells are the main users of butyrate as an energy source. Although it can pass across the blood-brain barrier, acetate is processed in muscle tissue. The liver can utilize propionate as a precursor to synthesize glucose. Moreover, short-chain fatty acids enhance the integrity of the intestinal barrier, lowering the risk of both localized and systemic inflammation. Preclinical research has made a compelling case for the possibility that short-chain fatty acids are important regulators of physical performance.

During intense physical activity, the host supplies lactate, a fuel source for some bacteria. These bacteria then generate metabolites, including propionate, that are advantageous to the exercising host (Marttinen et al., 2020).

PROBIOTICS AS AN EFFECTIVE ERGOGENIC SUPPORT TO ENHANCING ATHLETIC PERFORMANCE

It has been shown that probiotic supplements help to sustain and modulate the composition of the gut microbiota. Probiotics are a diverse group of bacteria, but the most well-researched probiotics include those from the genera Lactobacillus (and related genera) and Bifidobacterium. Animal research has examined the connections between probiotics and physical performance, as well as the possible mechanisms behind these effects. These studies have revealed that probiotic administration offers protection against the unwanted physiological changes that intense exercise may cause. Probiotics can reduce the inflammatory response, and improve the gut barrier characteristics in animals following strenuous exercise, according to preclinical research. It is unknown, therefore, how these protective benefits relate to outcomes related to physical performance (Unsal, C., et al., 2018).

DIRECT LINK BETWEEN PROBIOTIC CONSUMPTION AND IMPROVED PERFORMANCE

Studies show that probiotic yogurt supplementation can improve endurance athletes' VO_2 max and aerobic power. In adolescent female swimmers, probiotic yogurt containing specific strains (Lactobacillus Acidophilus SPP, Lactobacillus Delbrueckii Bulgaricus, Bifidobacterium Bifidum, and Streptococcus Salivarus Thermnophilus) showed significant improvements in VO_2max. Additionally, endurance runners showed an improvement in fatigue times in a hot environment with probiotics containing specific strains (one capsule per day containing 45 billion CFU of Lactobacillus, Bifidobacterium, and Streptococcus strains) [Shing et al., 2013].

Although it remains to be fully researched, there may be a connection between probiotic use and athletes' higher VO_2 max and tiredness because of things like shorter workout delays, fewer URTIs, and lower levels of inflammatory cytokines. To ascertain the cause-and-effect relationship, more investigation is required (Díaz-Jiménez, Jara, et al., 2012).

MATERIALS AND METHODS

The effect of curd (Indian dahi probiotic) supplementation on sports performance (VO_2 max) in resident female athletes in the age group of 18-25 years of the Sports Development Authority of Tamil Nadu was studied. This research has the potential to shed light on the role of curd as a nutritional intervention for optimizing cardiovascular fitness and endurance in the context of sports development. The participants were provided 100 ml of Indian curd (Dahi) for a period of 45 days. All athletes were given the same type of diet during the 45 days of curd supplementation and no other outside foods were consumed. The VO_2 max values were assessed using the Harvard step test on the 0^{th}, 15^{th}, 30th, and 45^{th} day of curd supplementation.

AIM OF THE STUDY:

The present study was carried out to determine the effect of curd intake on the sports performance (VO_2 max) of athletes aged between 18-25 years.

OBJECTIVES OF THE STUDY:

1. To provide curd as a supplement to the athletes for a period of 45 days.
2. To assess the effect of curd supplementation (100 ml) on the athlete's sports performance (VO_2 MAX).
3. To assess the VO_2 max of the participants using the Harvard step test
4. To monitor and record the changes in VO_2 max levels before, during, and after the curd intake (100 ml).

SITE OF THE STUDY:

Sports Development Authority of Tamil Nadu, Jawaharlal Nehru Stadium, Chennai hostel for girls (government undertaking).

DESIGN OF THE STUDY

The present study was carried out by the guidelines of the independent institutional ethics committee. Baseline data was collected through the questionnaire. The interventional study has been employed before, during, and after the curd consumption of 100ml.

SELECTION OF THE PARTICIPANTS
INCLUSION CRITERIA:

The criteria for the selection of the participants:

- Participants should prefer curd.
- Aerobic female athletes were included as study participants
- The athletes should be within the age group of 18 – 25 years
- Participants who do not have lactose intolerance
- Participants who are residing in a single campus hostel, following the same menu pattern and meal timings

EXCLUSION CRITERIA:

- Participants who are allergic to curd
- Participants who have digestive discomfort after curd consumption
- Participants who consume other types of probiotics.
- Participants who are on any other ergogenic supplements or sports drink formulation.
- Participants who consume outside foods
- Male participants

SAMPLE SIZE

The sample size consisted of 30 female athletes involved in aerobic sports based on the inclusion and exclusion criteria

DURATION OF THE STUDY

The study period was from November 2023 to March 2024. The interventional study was carried out for a period of 45 days of curd supplementation.

PHASES OF THE STUDY:

PHASE I

In the first phase of the study, a questionnaire was administered to 57 athletes of the Sports Development Authority of Tamilnadu from the response obtained, 30 participants for curd supplementation were selected based on the inclusion and exclusion criteria. A consent form is given to all the participants and the procedures are explained clearly to all the participants.

PHASE II

Data such as body weight, height, BMI, and VO_2 max assessment of the participants were assessed using the Harvard step test before the curd supplementation period.

PHASE III

Supplementation of 100ml of Indian curd (dahi) was given to all 30 participants for a period of 45 days. A tracker has been given to all the participants to ensure the regular intake of curd. The effect of curd on VO_2 max was assessed every 15 days once to see the difference.

PHASE IV

At the end of 45 days of curd supplementation, the final VO_2 max values were measured. The impact of curd before, during, and after the curd supplementation was observed.

Table 2

SUPPLEMENTATION AND ASSESSMENT PATTERN FOLLOWED IN THE PRESENT STUDY

Days	**Procedure**
0	VO_2 max Assessment *
1 – 15	Curd supplementation
15	VO_2 max Assessment*
16 - 30	Curd supplementation

30	VO_2 max Assessment*
31 - 45	Curd supplementation
45	VO_2 max Assessment *

HYPOTHESIS:

Based on the above objectives the following hypothesis were formulated and are presented in a null form

Hypothesis I:
There is no significant difference in the VO_2 max (sports performance) of the participants before and after 15 days of supplementation.

Hypothesis II:
There is no significant difference in the VO_2 max (sports performance) of the participants before and after 30 days of supplementation.

Hypothesis III:
There is no significant difference in the VO_2 max (sports performance) of the participants before and after 45 days of supplementation

TOOLS USED FOR THE STUDY

1. QUESTIONNAIRE

The questionnaire was used to select the participants based on their age, dietary habits, training, and allergies. A copy of the questionnaire is presented in Appendix

2. ANTHROPOMETRIC MEASUREMENTS

a. WEIGHT

The weight of the participants was taken before the curd supplementation using a weighing scale.

b. HEIGHT

The height of the participants was taken before the curd supplementation period using a stadiometer.

3. BODY MASS INDEX

BMI is calculated using the formula BMI = Weight (Kg) / Height (m^2).

4. HARVARD STEP TEST

The Harvard Step Test was used to estimate the maximum oxygen consumption (VO_2max) of the participants. The test involves stepping up and down on a bench or step at a specified rate, and the heart rate response during recovery is used to estimate aerobic fitness. The test is taken by the athletic coach. The procedure is given in the appendix.

FORMULA TO CALCLATE THE VO2 MAX:

VO2 max will be measured using the Harvard step test (taken by the athletic coach) which gives the maximum and minimum heart rate, and these values will be substituted in the formula

VO2 max = 15 x (HRmax/HRrest) (Uth, Niels et al, 2004).

Table 3

NORMATIVE DATA OF VO2 MAX VALUES FOR FEMALE

(Values in ml/kg/min)

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25	25 - 30	31 – 34	35 - 38	39 - 41	>41
20-29	<24	24 - 28	29 – 32	33 - 36	37 - 41	>41
30-39	<23	23 - 27	28 - 31	32 - 36	37 - 40	>40
40-49	<21	21 - 24	25 - 28	29 - 32	33 - 36	>36
50-59	<20	20 - 22	23 - 26	27 - 31	32 - 35	>35
60+	<17	17 - 19	20 - 24	25 - 29	30 - 31	>31

(HEYWOOD 1998)

PREPARATION OF CURD

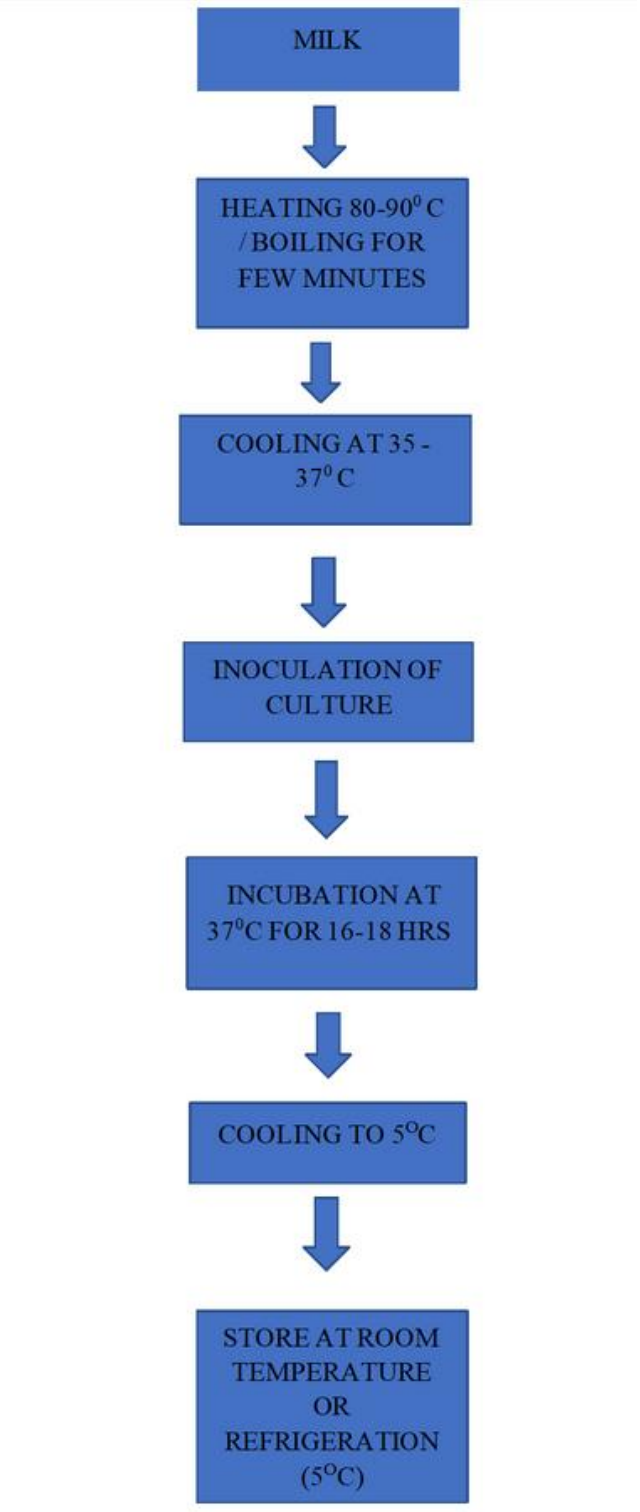

Fig. 1. Flow chart for the preparation of curd

Dietary pattern

The data revealed that all 30 participants preferred curd. As all the participants belonged to government hostels, they all followed similar menu patterns and meal timings. No outside foods or other types of probiotic foods were consumed by them.

Exercise pattern

The participants were all involved in aerobic sports. All 30 participants were trained by the coach daily for about 4 hours. Their training sessions started in the morning for about 2 hours and again in the evening for about 2 hours. The sessions were every day except on Sunday.

Test performed

Thirty participants were provided with 100 ml of curd for the first 15 days. The aerobic capacity was assessed using the Harvard step test before the supplementation of the curd. The same procedure was carried out every 15 days, that is, 45 days of supplementation.

BACTERIAL STRAINS AND COLONIES PRESENT IN INDIAN DAHI:

Bacterial strains: Lactococcus lactis, Streptococcus diacetylactis, Streptococcus cremoris, Lactobacillus delbrueckii subsp. bulgaricus, and Streptococcus thermophiles are the bacterial strains present in Indian dahi

No of colonies per 100ml: 10^{8-9} cfu/head/d

STATISTICAL ANALYSIS

The data collected from participants were subjected to the following statistical test:

a. Arithmetic mean
b. Standard deviation
c. Student ‘t’ test

RESULTS AND DISCUSSION

The results of the present study entitled ‘Effect of curd (Indian dahi) intake on the sports performance (VO_2 max) in resident female athletes of sports development authority of Tamil Nadu’ were participated in suitable statistical tests and the findings are discussed in this chapter. Thirty participants aged between 18-25 years, who are involved in aerobic sports were selected based on certain criteria. The probiotics (Indian dahi) were administered to the participants for a period of 45 days.

A questionnaire was used to elicit information from the participants on age, sports discipline, dietary habits, training and performance, health, and well-being. The body height and weight were also recorded before the supplementation.

The VO_2 max values of the participants were recorded using the Harvard step test before starting the curd supplementation. The VO_2 max measurements were done every 15 days, starting from

the first day of supplementation.

The results of the study have been discussed under the following headings,

1. Participants information
2. Dietary habits
3. Training and performance
4. Health and well being
5. Processing data for inferential statistical analysis
6. Hypothesis testing

From the population (N=57), thirty participants were selected according to certain criteria.

INCLUSION CRITERIA INCLUDE:

- Participants should prefer curd.
- Aerobic female athletes were included
- The athletes should be within the age group of 18 – 25 years

1. Athletes who prefer curd

Table 4

Per cent distribution based on the curd preference of the athletes

	(N=57)	
Prefer curd	**Number**	**Per cent**
No	6	11
Yes	51	89

From Table 4, it is found that 89 per cent of the athletes prefer curd, and only 11 per cent do not prefer curd. So curd is preferred to be a possible source of probiotic bacterial strains (Halder and Shyamapada, 2015).

2. Sports discipline

Table 5

Per cent distribution based on the various sports disciplines of the athletes

	(N=57)	
Sports discipline	**Numbers**	**Per cent**
Athletics	10	18
Basketball	8	14

Boxing	4	7
Football	14	25
Judo	4	7
Volleyball	13	23
weight lifting	4	7

It can be observed from Table 5, that all athletes (N = 57) were involved in various sports. The highest percentage of participants are involved in football (25%), volleyball (23%), athletics (18%), and basketball (14%). The lowest percentage of athletes are involved in boxing, judo, and weightlifting (7%).

According to Patel, Harsh et al. (2017), skeletal muscles increased by 60% in the aerobic interval training group, which was accompanied by a 46% rise in peak VO2. So the researcher used participants who are trained in aerobic sports.

3. Age

Table 6
Per cent distribution based on the age of the athletes

	(N=57)	
Age	**Number**	**Percent**
18	26	46
19	10	18
20	14	25
21	7	12

It is observed from Table 6 (N = 57) that 46 and 18 per cent of athletes were between the ages of 18 and 19, 25 per cent under the age of 20, and only 12 per cent under the age of 21. An article shows that an individual's VO2 max usually decreases with age. It usually peaks at the age of 20 and begins to diminish.

EXCLUSION CRITERIA

- Participants who are allergic to curd
- Participants who have digestive discomfort
- Participants who consume other types of probiotics.
- Participants who consume outside foods

1. Participants with lactose intolerance

Table 7
Per cent distribution of the athletes based on the prevalence of Lactose intolerance

	(N=57)	
Lactose intolerance	**Number**	**Per cent**
No	48	84
Yes	9	16

From Table 7, it shows that 84 per cent of the athletes are not lactose intolerant, and only 16 per cent of the participants are lactose intolerant. These athletes were excluded from the study.

2. Digestive discomfort

Table 8
Per cent distribution based on the digestive discomforts experienced by the athletes

	(N=57)	
Digestive discomfort	**Number**	**Percent**
I don't know	26	46
No	31	54

It is observed from Table 8, that most don't know (46%) or experience any digestive discomfort (54%). Athletes who have digestive discomfort have been excluded from the study. The study aims to find the effect of curd on sports performance.

3. Consumption of other probiotics

Table 9
Per cent distribution based on the consumption of other probiotics

Options of probiotics	**Number**	**Per cent**
Buttermilk	6	11
Cheese	6	11
Pickles	12	21
No	33	58

From Table 9, it is observed that 11 per cent of the athletes consume buttermilk and cheese. 21 per cent of the athletes consume pickles; the majority of the athletes, around 58 per cent, did not consume any other probiotics. The study aims to find the effect of curd on sports performance. So the athletes

who consume buttermilk, cheese, and pickles were excluded from the study.

4. Consumption of outside foods

Table 10
Per cent distribution based on the consumption of outside foods by the athletes

	(N=57)	
Consumption of outside foods	**Number**	**Per cent**
No	38	67
Yes	19	33

From Table 10, found that 67 per cent did not consume outside foods whereas 33 per cent will consume outside foods. Those who consume outside foods were excluded from the study.

1. Participants information

a) Age

Table 11
Per cent distribution based on the age of the participants

	(n = 30)	
Age	**Number**	**Per cent**
18	19	63
19	6	20
20	5	17

From Table 11 (n = 30), it shows that 63 per cent of the participants are over the age of 18, 20 per cent are over the age of 19, and only 17 per cent of the participants are over the age of 20. The cardiorespiratory fitness of women declines with age.

However, body composition and habitual physical activity are related to cardio- respiratory fitness. Statistical models show that while fitness levels declined continuously over time, the decrease was not linear or steady. Cardio-respiratory fitness declined more rapidly after age 45 (Andrew et al., 2009). Therefore the athletes aged between 18-20 were chosen as participants.

Table 12
Mean VO2 max values according to the age of the participants

	(n = 30)	
Age	**Initial**	**Final**
	Mean ± SD (VO2 max)	**Mean ± SD (VO2 max)**
18	23.89 ± 5.54	29.42 ± 4.74
19	25 ± 7.28	27.5 ± 6.80
20	24.4 ± 2.79	34.8 ± 2.58

According to Warpeha (2003), even at about the age of 18, the body is still developing, so the VO2 max was found to be less at the age of 18 years. From Table 12, also it is found that there is a decreased VO2 max value at the age of 18 before the curd supplementation.

The increase in VO2 max values was found to be the highest in the age group (20 years) after the curd supplementation when compared to other age groups after the curd supplementation. VO2 max naturally increases with growth up to about 20–25 years and then begins to decline at a rate of about 1% per year (Buckley et al., 1999).

b) Sports discipline

Table 13
Mean VO2 max according to the sports discipline of the participants

Sports discipline	**(n=30)**	
	Initial	**Final**
	Mean ± SD (VO2 max)	**Mean ± SD (VO2 max)**
Basketball	20.5 ± 3.20	28.25 ± 2.17
Athletics	28.69 ± 4.82	29.62 ± 5.27
Football	20.89 ± 2.93	30.22 ± 7.07
Volleyball	20.75 ± 4.35	32 ± 5.35

From Table 13, it is observed that there is an increase in the mean VO2 max of the participants before and after the supplementation, according to the sports discipline. From the initial mean VO2 max, it was found that athletics (28.69 ± 4.82) had the highest VO2 max values.

Among these sports disciplines, football (30.22 ± 7.07) and volleyball (32 ± 5.35) players had an increase in their VO_2 max values compared to other sports disciplines after the supplementation.

So the group that benefited the most from the curd supplementation was found to be the volleyball players. A study also found that volleyball players had greater VO_2 max values (Kausar Afshan et al., 2015).

c) Years have been the athletes actively participating

Table 14
Per cent distribution on the years that athletes have been actively participating

	(n = 30)	
Years of actively participating in sports	**Number**	**Per cent**
4 – 6 years	13	43
More than 7 years	17	57

Table 14 (n = 30), shows that 43 per cent of the participants were actively engaged in sports for a duration of 4-6 years, and 57 per cent of the participants were actively engaged in sports for more than 7 years. A study noted that aerobic work capacity can rise in response to training more quickly and significantly (Hickson et al., 1977).

Table 15
Mean of the VO_2 max according to the years that athletes have been actively participating

Years	**(n = 30)**	
	Initial	**Final**
	Mean ± SD (VO_2 max)	**Mean ± SD (VO_2 max)**
4 – 6 years	23.31 ± 4.87	29.92 ± 3.93
More than 7 years	24.88 ± 6.15	29.94 ± 6.53

From Table 15, it is observed that the VO_2 max of the athletes who have been active in sports for more than 7 years has seen an increase in their VO_2 max values. The initial mean VO_2 max values were slightly better for participants who had more than 7 years of training when compared to those with fewer years.

There is not much difference between the two groups. But according to (Ma et al., 2023) long-term training raises the VO2max values.

ANTHROPOMETRIC MEASUREMENTS

a) Weight and height

Table 16
Mean of the weight and height of the athletes

(N=57)	
Weight (kg)	**Height (cm)**
Mean ± SD	**Mean ± SD**
54.96 ± 8.13	161.86 ± 9.64

From table 16 it shows that the mean weight of the participants (54.96 ± 8.13) and the height of the participants (161.86 ± 9.64)

b) BMI (Body mass index)

Table 17
Per cent distribution based on the Body Mass Index of the participants

	(n=30)	
BMI	**Number**	**Per cent**
<18.5 (Underweight)	6	20
18.5 - 24.9 (Normal)	24	80
25 - 29.9 (Overweight)	-	-
30 - 34.9 (Obese class I)	-	-
35 - 39.9 (Obese class II)	-	-
>40 (Obese class III)	-	-

The participants were categorized based on the BMI classification given by WHO, 2004.

It is observed from Table 17, (n=30) that a majority of the participants (80 per cent) had a normal BMI (18.5-24.9) and 20 per cent were underweight (<18.5).

People with lower BMIs exhibit a drop in aerobic capacity, indicating that changes in BMI are accompanied by gradient changes in aerobic capacity (FAO, 1994).

Table 18
Mean of the VO_2 max according to the BMI of the participants

Parameters	Initial	Final
	Mean ± SD (Kg/m^2)	Mean ± SD (Kg/m^2)
<18.5 (Underweight)	24.83 ± 7.73	29 ± 7.21
18.5 - 24.9 (Normal)	23.92 ± 5.10	30.75 ± 4.30

It is evident from Table 18, that the initial mean VO_2 max of the athletes who are underweight (24.83 ± 7.73) had an increased VO_2 max value before curd supplementation.

Normal-weight athletes had an increase in VO_2 max compared to underweight athletes after the supplementation. According to Buckley et al., 1999, it shows the comparison of VO_2 max becomes difficult among individuals who differ in body size or body composition.

VO_2 MAX ASSESSMENT:

a) VO_2 max assessment after15 days:

Table 19
Comparison of the difference in the mean VO_2 max values between 0 to 15 days of curd supplementation

Parameters	(n = 30)	
	Initial	After 15 days
	Mean ± SD	Mean ± SD
VO_2 (ml/kg/min)	24.2 ± 5.60	25.27 ± 6.01

It is observed from Table 19, that there is a slight increase in the mean VO_2 max values after 15 days of curd supplementation, but the difference between the initial (24.2 ± 5.60) and after 15 days of curd supplementation was found to be less (25.27 ± 6.01). Therefore the shorter the period of supplementation, the lesser the effect of curd on the VO_2 max values.

According to the study, a four-week multi-strain probiotic treatment extended the duration of jogging until tiredness in the hot weather (Shing, Cecilia M et al., 2014).

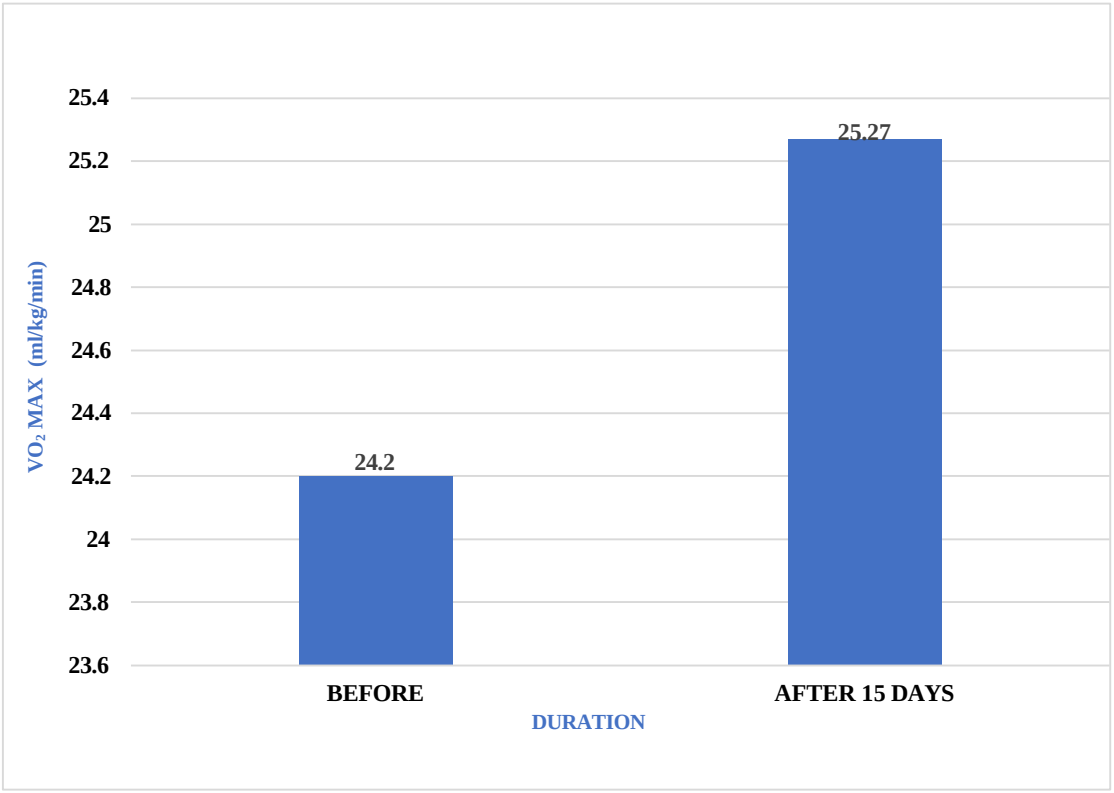

Fig. 2. Mean VO2 max values between 0 to 15 days of curd supplementation

b) VO2 mas assessment after 30 days:

Table 20

Comparison of the difference in the mean VO2 max values between 0 to 30 days of curd supplementation

Parameters	**(n = 30)**	
	Initial	**After 30 days**
	Mean ± SD	**Mean ± SD**
VO2 (ml/kg/min)	24.2 ± 5.60	29.5 ± 5.71

From Table 20, it is found that there is a significant increase in the mean VO2 max values after 30 days of curd supplementation, but the difference between the initial (24.2 ± 5.60) and after 30 days of curd supplementation was found to be more. According to Salehzadeh, K. (2015), over the course of 30 days, thirty endurance athletes who were supplemented with a yogurt drink had a significant increase in VO2 max values.

The researcher also found a similar significant increase in the VO2 max levels after 30 days of curd supplementation.

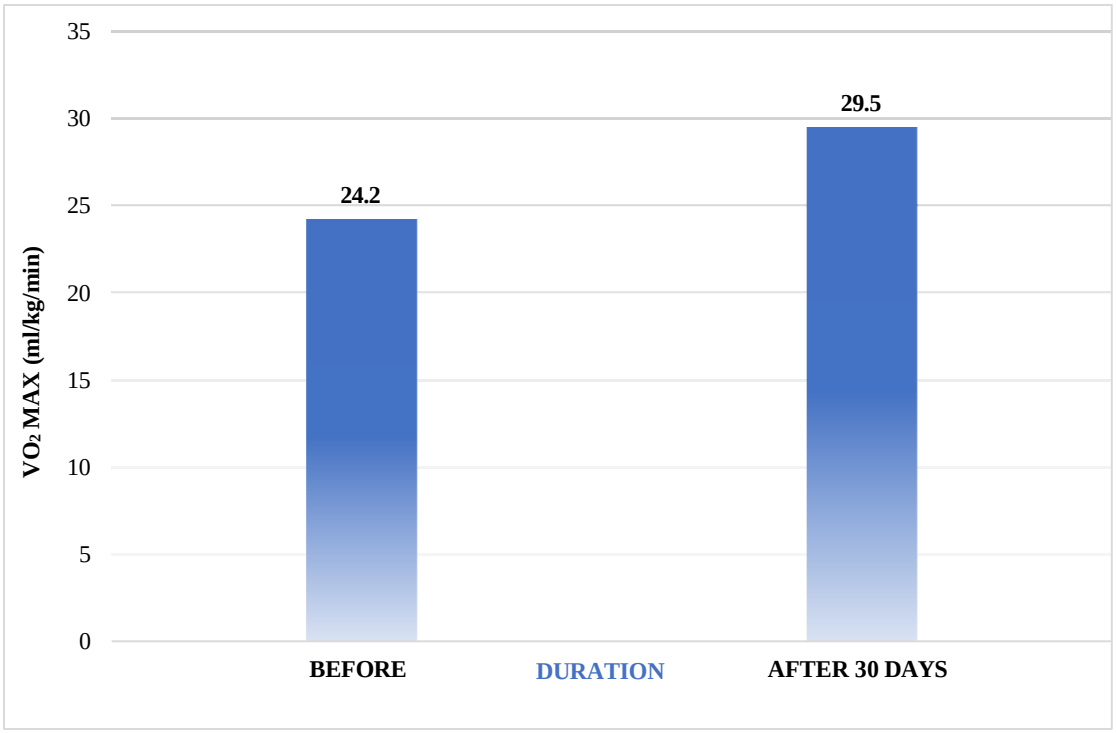

Fig. 3. Mean VO2 max values between 0 to 30 days of curd supplementation

c) VO2 mas assessment after 45 days:

Table 21

Comparison of the difference in the mean VO2 max values between 0 to 45 days of curd supplementation

Parameters	**(n = 30)**	
	Initial	**Final**
	Mean ± SD	**Mean ± SD**
VO2 (ml/kg/min)	24.2 ± 5.60	29.93 ± 5.47

It is observed from Table 21, that there is a significant increase in the mean VO2 max values after 45 days of curd supplementation, but the difference between the initial (24.2 ± 5.60) and final (29.93 ± 5.47) VO2 max values was found to be higher.

Huang, Wen-Ching, et al., 2018 observed that 6 weeks of probiotic supplementation increased aerobic endurance noticeably.

Therefore the longer the period of supplementation, the greater the effect of curd on the VO2 max values.

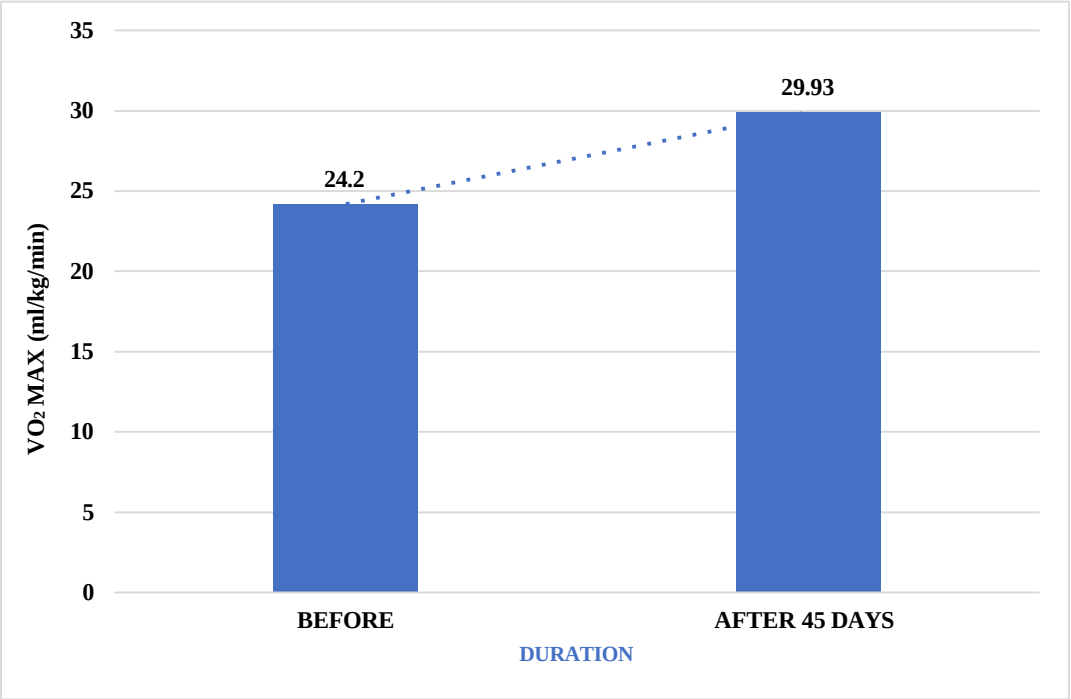

Fig. 4. Mean VO2 max values between 0 to 45 days of curd supplementation

TESTING OF THE HYPOTHESIS

Hypothesis I:

There is no significant increase in the VO2 max (sports performance) of the participants before and after 15 days of supplementation

Test statistic

The 't' value obtained was 1.69 and is statistically significant ($p<0.05$)

Period of evaluation	't' value	'p' value
0^{th} – 15^{th} days	1.699127027	0.046449647

Inference

There is a significant increase in the VO2 max values (sports performance) of the participants after the 15 days of curd supplementation using "The Harvard step test". Therefore the null hypothesis is rejected.

Hypothesis II:

There is no significant difference in the VO2 max (sports performance) of the participants before and after 30 days of curd supplementation.

Test statistic

The 't' value obtained was 1.69 and is statistically significant ($p<0.05$)

Period of evaluation	't' value	'p' value
0^{th} – 30^{th} days	1.699127027	0.000574578

Inference

There is a significant increase in the VO2 max values (sports performance) of the participants after 30 days of curd supplementation using "The Harvard step test". Therefore the null hypothesis is rejected.

Hypothesis III:

There is no significant difference in the VO2 max (sports performance) of the participants before and after 45 days of curd supplementation.

Test statistic

The 't' value obtained was 1.69 and is statistically significant ($p<0.05$)

Period of evaluation	't' value	'p' value
0^{th} – 45^{th} days	1.699127027	0.000406566

Inference

There is a significant increase in the VO2 max values (sports performance) of the participants after 45 days of curd supplementation using "The Harvard step test". Therefore the null hypothesis is rejected.

SUMMARY AND CONCLUSION

Cardiovascular endurance refers to the human ability to exert themselves through aerobic or anaerobic exercise for extended periods, affecting the heart, lungs, and their systems. It enhances heart muscle strength, improves respiration efficiency, and normalizes blood pressure. Aerobic fitness is measured by VO_2 max, which measures oxygen transport and utilization. Regular exercise intensity alters VO2 max, and heart rate responses to standard workloads indicate physical fitness changes.

The study was conducted to evaluate the effect of curd on the VO2 max (sports performance) of female athletes involved in aerobic sports. The sports performance (VO2 max) of the athletes was assessed using the Harvard step test and was recorded before curd supplementation and also on the 15th, 30^{th,} and 45th day of curd supplementation.

SUMMARY OF THE FINDINGS

- The VO2 max values were higher for the age group - 20 years when compared to other age groups. VO2 max generally increases up to the age of 20-25 years and begins to decline after 25 years.
- Among the various sports disciplines, the volleyball and football players had higher VO2 max values after the curd supplementation.
- The athletes who were active in sports for more than 7 years had higher VO2 max values before and after curd supplementation which shows the importance of more years of training along with curd supplementation.
- Athletes who had normal BMI had a greater increase in VO2 max values compared to underweight athletes after curd supplementation.
- A shorter period of curd supplementation that is 15 days had a lesser impact on the sports performance (VO2 max) among the athletes.
- When compared to 15 days of curd supplementation, 30 days of curd supplementation had a significant effect in increasing VO2 max values.
- The 45 days of curd supplementation had the maximum benefit of VO2 max value of athletes.

Therefore the longer period of supplementation may prove to be very beneficial to the athletes in improving their sports performance (VO2 max).

CONCLUSION

It can be concluded from this study that the supplementation of curd for 30 days is sufficient to enhance the endurance capacity of aerobic sports athletes. There is evidence that athletes who are supplemented with probiotics have significant improvements in their VO2 max values (Salehzadeh, K. 2015). This study shows that the curd intake benefited the athletes in terms of their oxygen intake and endurance level.

Suggestions for further research

- To conduct a similar study with male athletes
- To assess the effect of curd supplementation for longer periods
- The effect of other types of probiotics on the VO_2 max can be studied.