EFFICACY OF SORGHUM BASED SUPPLEMENTARY SPORTS FOOD ON PHYSICAL ENDURANCE OF BASKET-BALL PLAYERS

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1. INTRODUCTION

When every thing else is equal, nutrition can make the difference in sports performance. In today's world of neck and neck competition, a person cannot afford to take chance in any area as minute fraction can deprive him of fame and fortune, proper physical training combined with sound nutrition can go a long way in getting optimal results. In general "sports nutrition" can be defined as, a special application of science of nutrition to performance enhancement in sports. To become all rounder in sports and games, whether it is cricket, gymnastic, swimming or foot ball or any other, an individual need to eat nutritious, balanced food which are derived from carbohydrates, fats as well as essential protein.

Carbohydrate is stored as glycogen in the muscle and liver, it is the "energy store" in muscles used for aerobic and anaerobic endurance activities. Maximizing these stores results in better endurance, delayed fatigue and hence improved performance. During exercise, glycogen is broken down into glucose to supply the muscle with energy. Inadequate glycogen repletion may lead to heavy tired muscle, poor performance and general fatigue. During prolonged exercise, fat stores are predominant fuel sources, well trained endurance players burn fat more efficiently, sparing limited glycogen stores. Fat intake should be adequate to provide essential fatty acids and fat soluble vitamins, as well as to help adequate energy for weight maintenance. During times of high physical activity, energy and macro nutrient needs- especially carbohydrate and protein must be met in order to maintain body weight, replenish glycogen stores, and provide adequate protein for building and repairing tissues. Players require more protein than non players and it is important to repair muscle tissue after exercise. Timing and type of protein consumption is an important aspect to be considered. Recent data indicate that consuming a small meal of mixed carbohydrate and protein composition before an event or exercise results in improved performance (Saunders *et al.*, 2004).

Dehydration can compromise exercise performance and it is therefore important to start exercise in a euhydrated state. A fluid loss of 6 per cent to 10 per cent of body mass may result in shortness of breath, dizziness, circulatory disorders, vomiting, and muscle cramping. Hence along with proper sport supplementation, player should follow proper hydration techniques before, during and after the events or exercise.

Certain general principles of conditioning and nutrition are common to all sports, but specific emphases are important for optimal performance in each sport. Team sports players need to follow sound nutrition principles to optimize their body composition, recover daily after training, and they need to consume optimal fuel prior to training and competition. These players also have unique nutritional needs based on the type of training sessions specific to their sports.

In India very few studies are conducted in the field of sports nutrition and its impact on performance level. Information regarding nutrition, nutrient intake and impact of supplementation in relation to specific team game is not available. Basket-ball which is selected for the present study is one of the most popular "stop-and-go" team sports. It places a unique physical and mental demand upon its players; it is a game of precision, anticipation and calculation. Basket-ball players must be a combination of sprinter, leaper and even dancer to execute the fundamental movements of the game. Basket-ball conditioning must, therefore taken into account the fact that a player has several things going on at once both in mind and body while he is playing game. Only the most rigorous training and nutritional program can prepare a player for full court basket-ball season.

The basic pre-requisites of a basket-ball player is to maximize speed, agility and power, to accomplish these goals from a nutritional stand point, they need a training and a supplementary food along with their daily diet which has enough energy and key nutrients most notably macronutrients and fluids. Most of the players at the elite level are active all years, training loads vary according to time of the season and the number of games played each week. During competitive season, the team will normally have 3-4 team session per week, plus individual session. A basket ball player should divide his calorie intake to match the energy demand during the pre-season, seizing off season. The targets per cent of macronutrient pre-season and off season period are 60 per cent carbohydrate, 20 per cent each protein and fat. Basket-ball players are combination of power-middle distance and endurance player, every position must obtain energy from each of the three energy systems. Therefore, a basket-ball player needs to plan his nutritional intake, from both daily diet and a supplementary source to support all three systems.

To maintain high intensity in the game and dominate the opponent, a basket-ball player need to have great endurance and the ability to recover quickly between bursts of sprint and jumps, and from one game to the next. Due to the nature of this intense and skill packed game, carbohydrate loss from glycogen stores can be significant and can exceed threshold at which performance may become impaired. Thus beyond adequate training, a top priority for player should be proper timing of fueling *i.e.* before, during and after the game or exercise.

Energy need of basket-ball player can be as high as 50 kcal/kg of body weight. This level of energy need can be met only through using work out food supplements or fluid surrounding training and game times. Due to high intensity nature of the game a high carbohydrate diet is required which enables them to use glycogen as the primary energy source for most of their training sessions and games. Complex carbohydrate sources are the best sources because it bait most actively and refill the glycogen store in the muscle and liver. In many research findings it has been suggested that, there are performance benefits to be gained from eating carbohydrate foods with a low rather than high Glycemic Index (GI) before exercise. Low-GI carbohydrates, by definition, do not significantly raise plasma glucose and insulin concentrations after eating. Logically, these effects might be expected to improve endurance performance.

Products such as pastas, baked bean, oat meal are more suitable for sports food as these causes less stomach upset and indigestion. The minimal perturbation of glucose homeostasis and slower digestion and absorption of low GI carbohydrates causes a sustained and slower release of glucose into the circulation and minimize any insulin-induced reduction in plasma fatty acid concentrations before exercise. As the basket-ball game is a combination of power middle distance endurance, a basket-ball player must make sure that he should consume adequate amount of both carbohydrate and protein. Consuming complex carbohydrate sources an hour prior to event, leads to lower blood sugar and insulin level (Costill *et al.,* 1981) which results in sustained exercise performance. Consuming high GI, simple carbohydrate before exercise or event will raise blood glucose and insulin levels. When these levels are elevated just prior to exercise there is a potential for a rebound drop in blood glucose level (hypoglycemia) and an increased use of carbohydrate store during exercise. This may not be good for a player's performance and endurance. Hence, complex carbohydrates are more suitable for pre-exercise or pre-event sports supplement.

The supplement should be mainly carbohydrate with a proper quantity of protein and little or no fat. Low and moderate GI carbohydrate source such as whole grain cereals are preferable as they provide more lasting energy. Most of the sports drinks do not contain protein, however new research from leading exercise laboratories is now showing that, sports drink that contain protein in the right balance with carbohydrate can delay fatigue, even longer than a sports supplement that contain only carbohydrate (Williams *et al*., 1992). Protein content in such supplements are derived from food sources such as, milk, egg, or soy protein. Protein in a sports supplement may offer an additional advantage in helping muscle to recover fast.

Most of the sportsmen especially basket-ball players are more susceptible to losing iron due to high intensity nature of the game when compared with other players, causing red blood cell to be destroyed and plasma iron to be lost. Hence most of the players experience "sports anemia" which is believed to be due to intense training. Many studies have shown a beneficial role for soy protein when used as supplement to improve plasma iron status, as soy flour contains 6 mg of iron/100 g of flour. Soy protein also helps in increasing the body's antioxidant status, reducing fatigue after exercise and minimizes tissue inflammation, which occurs during exercise and improves physical strength and performance with improved level of maximum oxygen uptake.

There are thousands of supplementary sports foods available in super markets, sports shops and health shops with wide range of prices, which can definitely improve the endurance capacity and performance of a sportsmen. But some time most of these products are not available in all the places and are out of reach of budgeting sportsmen. In Indian sports context, where beverages are becoming more popular and fruit based beverages being expensive, there is a need to develop nutrient dense, chemical free, cost effective supplementary sports food using locally available food ingredients.

The dietary supplement used for the present study has been developed in the host department of food science and nutrition UAS, Dharwad, which serves all the above mentioned criteria as it contains low GI complex carbohydrate rich sorghum flour and high GI sugar powder, a moderate amount of protein rich soy flour and a little amount of skimmed milk powder in the proportion of 40:25:15:20 and protein calorie ratio of this product is 18 which is very suitable for a sportsmen. There is a need to promote such nutrient dense products in to the market and make it available to all classes of sportsmen to improve their endurance capacity and there by improving their performance level.

Hence, the present study was designed to test the efficacy of sorghum based supplementary sports food on physical endurance of basket-ball players with the following objectives:

1) To analyze the nutrient composition of a sports food
2) To characterize the sensory profile of sports food
3) To test the efficacy of sports food on physical endurance of basket-ball players

2. REVIEW OF LITERATURE

A comprehensive review of related literature provides background information and clear insight in the areas of research, which help the researcher to formulate and carryout research work. The concerned literature in connection with the study of nutritional status and intake of sportsmen, endurance capacity, endurance test and concept of sports food are presented hereunder.

2.1 NUTRITIONAL STATUS OF SPORTSMEN

Nutrition plays a very important role in attaining high level of achievements in sports. Nutritional status has a direct bearing on the level of physical performance. Hence, physical fitness and training are very much dependent on nutritional status of sports personnel. Generally most of athletes will have tall, muscular and well balanced physique, which is an indicator of good nutritional status. Anthropometric measurements and bio-chemical parameters are used to provide a basis for training and dietary intervention, which includes measurements of age, height, weight, body circumferences, skin fold thickness and blood hemoglobin levels.

The relationship of eating attitude to anthropometric variables of 14 female collegiate swimmers was studied by (Barr, 1991). The mean height was 168 cm, weight 63 kg, body fat 21.9 per cent and Body Mass Index (BMI) was 22. The relationship between dieting, binge eating, and oral control (ability to resist other pressure to eat) was assessed. Swimmers with higher BMI were more concerned about body size and dieting behavior, a positive relation existed between BMI scores and oral control.

Chandrasekhar and Jacob (1992) studied the nutritional profile of 80 adolescent boys from YMCA sports school Madras and 40 boys from Maratha College of sports school at Coimbatore, who were practicing foot ball, hockey, swimming, basket ball, volley ball and athletics. The mean height of all the groups were 164 $\pm$ 5.7 cm except swimmers 156.1 $\pm$ 71 cm, athletes and volley ball players were heavier i.e. 49.8 $\pm$ 5.8 kg and 51.5 $\pm$ 4.7 kg respectively and the mean weight of other group was 46.8 $\pm$ 4.6 kg. The arm circumference (22.9 $\pm$ 1.8 cm) and chest circumference (81.4 cm) of athletic players were greater than other players (21 $\pm$ 2 and 77.7 $\pm$ 4.2 cm). Athletes showed a higher hemoglobin level 11.5 $\pm$ 0.8 g/dl than the sportsmen in other groups 11.25 $\pm$ 0.8 g/dl.

Wan-Nudri *et al*. (1996) determined the anthropometric measurements and body composition of selected national athletes. A total of 84 male athletes from 10 different types of sports and 24 female athletes from 5 types of sports were studied. The mean body weights of male and female athletes were 68.8 $\pm$ 13.2 kg and 58.0 $\pm$ 7.6 kg, respectively. The male athletes from weight lifting team and female athletes from basket ball team were heavier i.e. 110.1 $\pm$ 7.4 kg and 61.4 $\pm$ 5.4 kg respectively. The mean heights of male and female athletes were 1.73 $\pm$ 0.09 m and 1.66 $\pm$ 0.08 m, respectively. The athletes from basket ball team were tallest group for male and female athletes, with a mean of 1.88 $\pm$ 0.05 m and1.70 $\pm$ 0.07 m respectively. The mean BMI and body fat of male athletes were 22.9 $\pm$ 3.5 kg/m2 and 13.8$\pm$4.5 per cent respectively while, for females 20.9 $\pm$ 2.0 kg/m2 and 24.7 $\pm$ 5.3 per cent respectively.

Ahluwalia *et al.* (1988) recorded the anthropometric measurements of 12 handball athletes and compared it with 12 non-athletes (16-20 yrs age). The height (151 to 166 cm) and weight (40-64 kg) of athletes were more than non-athletes (150-157 cm and 44-59 kg, respectively). The mid upper arm circumference, mid arm muscle circumference and triceps skin fold thickness ranged from 21.8 – 28.7 cm, 18-26.5 cm, 7-15.6 mm, respectively as against 20.7 – 25.7 cm, 16.4 – 19.3 cm, 11.5-26.8 mm in non-athletes.

Greene *et al*. (1998) studied the anthropometric and performance measures for high school basket-ball players. About 54 female and 61 male subjects were selected and anthropometric measurements like height, weight, body composition, ankle range of motion were taken on each of 115 subjects. Performance measures included the vertical jump, shuttle run, sprint and single limb balance time. The male subjects were taller and heavier, while female had a significant higher percentage of body fat. Males were able to jump significantly higher and run, shuttle run and sprint faster than female subjects.

Nutritional status of 63 elite female athletes (16-21 years) was found by Goswami and Mathur (1999) by recording BMI and hemoglobin level. The BMI values ranges from 16.8 to 23.0, where as mean hemoglobin level of middle distance runners was 11.6 $\pm$ 0.70 mg/100 ml, in sprinters and jumpers it was 10.4 $\pm$ 0.32 mg/100 ml and 9.0 $\pm$ 0.84 mg/100 ml respectively. Nutritional status of 18 male and 12 female trained athletes in the age group of 16-20 yrs was studied by Kavitha *et al.* (2001). The mean height, weight, mid arm circumference were high in male athletes (168.63 $\pm$ 7.7 cm, 56.25 $\pm$ 88 kg, 83.60 $\pm$ 5.15 cm) than female athletes (157.25 $\pm$ 4.7 cm, 46.80 $\pm$ 2.47 kg, 78.47 $\pm$ 1.93) where as triceps skin fold thickness was found higher in female athletes (9.35 $\pm$ 0.62 cm) than male athletes (7.45 $\pm$ 2.12 cm).

Tsunawake *et al*. (2003) evaluated the body composition (underwater weighing) and cardio respiratory function (VO2max and O2debt max) measured by the treadmill exercise test in 12 members of the women's volleyball team (mean age 17.4 years) and 11 members of the women's basketball team (mean age 17.6 years). The mean values of the height and body weight were 168.7 $\pm$ 5.89 cm and 59.7 $\pm$ 5.73 kg in the volleyball players and 166.5 $\pm$ 7.87 cm and 58.8 $\pm$ 6.85 kg in the basketball players. The mean per cent fat was 18.4 $\pm$ 3.29 per cent in the volleyball players and 15.7 $\pm$ 5.05 per cent in the basketball players. The mean VO2max was 2.78 $\pm$ 0.32 Lx/ min (46.5 $\pm$ 2.90 ml/ kg/ min) in the volleyball players and 3.32 $\pm$ 0.31 Lx/min (56.7 $\pm$ 4.17 ml/ kg/ min) in the basketball players.. The mean O2debt max was 6.18 $\pm$ 1.15 L (103.2 $\pm$ 12.40 ml/ kg) in the volleyball players and 7.92 $\pm$ 1.80 L (134.3 + 23.24 ml/ kg) in the basketball players. No significant difference was observed in any measured item of the physique, skin fold thickness, or body composition between the volleyball players and basketball players. The VO2max and O2deb max were 22 per cent and 28 per cent higher in the basketball players than in the volleyball players. The female volleyball players and basketball players had a large fat free mass and excellent aerobic and anaerobic work capacities.

Meti and Sarawathi (2006) studied the nutritional profile and impact of carbohydrate supplementation on 30 high school adolescent foot ball players. Samples were divided into (n=15) supplementation group and (n=15) control group. The mean height and weight of control and supplementation group were 161.0 $\pm$ 7.6 cm, 50.0 $\pm$ 4.5 kg and 160.0 $\pm$ 13.2 cm, 49.0 $\pm$ 9.9 kg respectively. The mean BMI and mid upper arm circumference of control and supplementation group were 19.3 $\pm$ 0.3cm, 25.3 $\pm$ 1.6 cm and 19.0 $\pm$ 4.8 and 24.5 $\pm$ 3.3cm respectively. The mean hemoglobin levels were 11.4 $\pm$ 1.1and 11.5 $\pm$ 0.9 in control and supplementation group respectively. There were no significant difference were observed in any of the anthropometric attributes of foot ball players.

Hence anthropometric indices are good indicators of nutritional status of sports men. A well balanced nutrient dense diet helps an athlete to achieve a good physical fitness in terms of height, weight, BMI, fat free mass etc. and also better performance in sports and nutritional requirements of sports men are very high when compared with RDA's of a common man. Hence it is very essential to study the nutritional requirements and intake of sportsmen.

2.2 NUTRITIONAL REQUIREMENTS FOR SPORTSMEN

Individual athletes differ in their nutritional requirements because of physical size, sex and nature of the sports activity. The first component to optimize training and performance through nutrition is to ensure the athlete is consuming enough calories to offset energy expenditure. Marathon runners, cyclists, and cross country skiers who need to sustain energy levels for longer periods of time may use from 2600-5000 calories (Nieman, 1986). Energy needs of basket-ball players can be as high as 50 kcal/kg of body weight, approximately 3400 kcal/day, as they expend tremendous amount of energy. Energy requirements of sportsmen mainly depend on the volume and intensity of different training phases, which ranges from 2600-5000 kcal/day.

Use of nutrient dense high calorie carbohydrate and protein supplement, helps in maintaining optimum energy intake level in athletes. For athletes, the national academy of sciences RDA for carbohydrate is 6-10 g/kg bodyweight. Athlete involved in moderate amounts of intense training need to consume 55-60 per cent carbohydrate i.e., 5-8 g/kg/day for 50-150 kg athlete, in order to maintain liver and muscle glycogen stores. Sportsmen involved in high volume intense training need to consume 8-10 g/day i.e., 400-500 g/day for an athlete weighing 50-150 kg.

Endurance athletes primarily use protein for maintaining aerobic metabolism, compared with the increased tissue-repair needs of strength athletes. When intake is inadequate, the body sequesters the needed proteins from lean tissue, which gives over trained endurance athletes a gaunt appearance. A protein deficit also impairs an athlete's recovery and wound-healing ability. Studies have shown that athletes involved in intense training need to ingest about 1.5-2.0 g of protein/kg/day. In order to maintain protein balance, athletes involved in moderate amount of intense training need to consume 1.0-1.5 g/kg/day, and athletes with high volume of intense training should consume 1.5-2.0 g/kg/day. Research has shown that on an average, endurance athletes obtain about 14 per cent of their daily energy from protein *i.e.*, 70 kg athlete with a daily energy intake of 3500 kcal would consume at least 120 g of protein everyday (Gibala, 2002). Only a few studies recommend protein intake levels as high as 2 g/kg of body weight/day.

Fat is essential to maintain energy balance and provide food during moderate intensity exercise. General recommendation is 36-40 per cent of athlete's daily calorie intake should be from fat. During prolonged exercise, fat stores are predominant fuel sources, well trained endurance athletes burn fat more efficiently, sparing limited glycogen stores. Fat intake should be adequate to provide essential fatty acids and fat soluble vitamins, as well as to help adequate energy for weight maintenance.

Vitamins and minerals are essential for metabolism of macronutrients and helps an athlete to tolerate heavy training by reducing oxidative damages (vitamin E and C) and also to maintain healthy immune system during heavy trainings (vitamin C).The American Medical Association (2000) has reported that the vitamins and minerals have little ergogenic value or no benefit of extra vitamin and mineral supplementation to sportsmen who consume normal daily nutrient dense diet.

The dietary status of 13-female high school gymnasts was examined by Moffatt (1984). The mean intake of energy (1923 Kcal) and protein (748) was 96 per cent and 161 per cent of RDA, respectively. The intake of riboflavin was 1.39 mg vitamin A-883 retinol equivalent, vitamin 8.1 mg, vitamin C 8.3 mg and it exceeded the RDA while thiamine 1.4 mg, niacin 13.36 mg, vitamin B12 2.39 mg, vitamin D 7.32 µg, iron 11.26 mg, calcium 706 mg were below 75 per cent of RDA (Recommended Daily Allowance).

Ellsworth *et al.* (1985) studied the dietary intake of 13 men and 14 women members of the US Nordic ski team during one year of training and competition. Four sets of three day diet records collected at 3-4 month intervals showed that the skiers although consuming high amounts of calories tended to have a similar in composition to the average American diet. Men consumed 3492-5400 kcal/day (49-76 kcal/kg). All the vitamins and minerals evaluated were well above the RDA. Cholesterol intakes were 655-1210 mg/day for men and 369-736 mg/day for women.

Deuster *et al.* (1986) evaluated the nutritional needs of 51 athletic women involved in endurance sports. Complete 3-day food records were obtained. The percentage of calories was 13 per cent, 35 per cent and 55 per cent for protein, fat and carbohydrate respectively. Mean calorie intakes of most minerals were above RDA.

Hickson *et al.* (1989) analyzed the effect of a University food service facility on 17 intercollegiate athletes in the age group of 18-22 years and who were staying on and off campus. On campus subjects derived more energy from carbohydrates than off campus subjects (52% vs. 42% kcal). This is due to selection of more grain products by subjects staying on campus. Mean intake of carbohydrate, magnesium and riboflavin for on campus subjects significantly exceed that off campus subjects.

Keith *et al.* (1989) analyzed the dietary status of 8 trained female cyclists (22 ± 5yrs) through 3-day weighed food record. Nutrient content were analyzed using a computerized software package and assessed hemoglobin, haematocrit and albumin levels. The cyclist diet was found to be low in energy (76% RDA), magnesium (81% RDA), iron (59% RDA) and zinc (48% RDA) while one-third of cyclist intake was below 67 per cent for pyridoxine, folacin, cobalamine, vitamin-E,magnesium, iron and zinc, hemoglobin (135 g/dl) and haematocrit (0.39 g/dl) further, albumin (45 g/dl) level were normal.

Lemon *et al.* (1992) studied the protein requirements and muscle mass/ strength change in 12 novice body builders [22.4 ± 2.4yrs] who received an iso-energetic protein (2.62

g/kg/day) or CHO (1.35 g/kg/day) for 1 month each during intensive (5 hr/day, 6 days/week) weight training. On the basis of 3-day Nitrogen Balance (NBAL) measurements after 3.5 week on each treatment.(8.9 ± 4.2 and 3.4 ± 1.9 g/day, respectively). The protein necessary for zero NBAL (requirement) was 1.4-1.5 g/kg/day. The recommended intake was 1.6-1.7 g/kg/day. Data indicates that is during early stages of intensive body building training, protein needs are approximately 100 per cent greater than RDA that protein increases from 1.35-2.62 g/kg/day do not enhance muscle mass or strength gain, during first month of training.

Nutritional intake of 63 elite female athletes (16-24 yrs) was found by Goswami and Mathur (1999) by recording their diet. All of them were taking equal amount of energy ranged from 3854 kcal in sprinters to 4126 kcal in throwers. The protein intake ranged from 156.1 g in sprinters to 121.9 g in throwers. Carbohydrate intake ranges from 10 g/kg bodyweight in jumpers and 9.4 g/kg bodyweight in sprinters.

Nutritional intake of 18 male and 12 female trained athletes (16-20 yrs) was studied by Kavitha *et al.* (2001). The mean intake of energy, protein, fat and carbohydrate were higher in male athletes (2972 ± 506 kcal, 90 ± 15 g, 125 ± 25 g and 338 ± 38 g) than female athletes (2371 ± 484 kcal, 67 ± 16 g, 91 ± 28 g and 320 ±15 g respectively). The micronutrient intake was significantly higher in male athletes when compared to female athletes, riboflavin (50%), niacin (35%), retinol (40%), vitamin-C (28%) and iron (< 28%) was less when compared to intake of thiamine and calcium which was more than 60 per cent.

Colombani *et al.* (2002) studied the nutritional intake of 12 male runners during a 244 km multi sports ultra endurance race. Their energy intake during the race was 22.6 (12.4-33.6) MJ and corresponds to 44 per cent of their estimated energy expenditure. Carbohydrate, net fluid and net sodium intake amounts to 60 (36-90) g/hr. 0.8 (0.1-2.4) g/kg body mass, 560 (310-790) ml/hr and 3 (7-19) mmol/l respectively.

Hassapidou *et al.* (2003) studied the dietary intake of 15 Greek basket-ball players. Dietary intakes were assessed using 3-d dietary diaries for each athletic season. Athlete’s mean energy intake decreased from the transitional (vacation) to the training season, and during competitive season most athletes were not in energy balance. Their mean protein intake varied from 11 per cent of energy intake during the transitional season to 16per cent during the competitive season. Carbohydrate provided 41-53 per cent of energy intake where as fat intake ranged from 32-48 per cent, indicating a diet high in fat and low in carbohydrate. Dietary intakes varied among the athletes but in general they had an unbalanced nutrition.

Schroder *et al.* (2004) studied the dietary habits of 55 elite Spanish basket-ball players through 24hr recall method. Energy consumption among these athletes was high 17.7 ± 0.9 MJ/day in comparison to other elite team sport athletes. further, more intake of protein , fat, saturated fatty acids, mineral and most vitamins exceeded the RDA’s for these macronutrients where as, intakes of carbohydrates and vitamin-E failed to meet the guidelines. Kelkar *et al.* (2006) evaluated the dietary nutrient composition of 78 sportsmen (18-25yrs) belonging to varied sports discipline *viz*., runners (n=20), boxers (n=21), weight lifters (n=21) and wrestlers (n=15). The intake of runners, boxers and weight lifters obtained 55-60 per cent, 12-15 per cent and 20-30 per cent of calories from carbohydrates, protein and fat respectively. And wrestlers obtain 34 per cent, 155 and 49 per cent of calories from carbohydrates, protein and fat respectively.

Martin *et al.* (2006) studied the nutritional practices and activity patterns of elite female soccer players. The nutritional intake of 16 female England Soccer players was self-reported over a seven-day period. Participants were provided with written and verbal guidelines for the completion of the diaries.Training details were also recorded, and used in combination with BMR predictions to calculate daily energy expenditure. Energy, macronutrient and micronutrient intakes were determined using, Diet Master 4.0 software. Results suggest that energy intake was low (1904 ± 366.3 kcal) in relation to previous recommendations for soccer players. Energy expenditure (2153.5 ± 596.2 kcal) was not significantly different (P > 0.05) from intake, suggesting energy balance was achieved. Carbohydrate (53.8 ± 6.8%),protein (16.8 ± 2.1%) and fat (28.8 ± 6.6%) intakes were in line with recommendations. Fluid intake (2466 ± 1350.5ml·day-1) was sufficient to meet baseline recommendations, but would need to be higher to meet the additional requirement of training and competition. With the exception of vitamin A and iron, all micronutrient intakes were higher than the RDA.

Deriemaker *et al.* (2007) studied the nutritional intake of 297 athletes (12 yrs) through 3-d food diary, 77 per cent of the subjects had a caloric intake below the recommended daily allowance (RDA), while 23 per cent had an intake above RDA. Macronutrient analysis showed for all groups a low carbohydrate intake, a high fat intake and protein intake was just near the upper limit of the RDA.

Above studies suggest that, nutritional intake of an athlete were sports specific and in terms of amount of total energy expenditure by an individual. In some studies it was observed that, the macronutrient intakes of athletes were below the recommendation, which is one of the most hindering factors which may contribute in poor endurance capacity and poor sports performance. Hence, athletes are recommended to eat nutrient dense foods which are rich in carbohydrate, and which is a fast and efficient source of energy and also essential to build up a good endurance capacity followed by proteins and fats.

2.3 ENDURANCE CAPACITY

Endurance, like strength, is a very important ability, it is a ability against fatigue, and it enables the sportsmen to do a sports activity effectively without getting tired and to recover quickly. Nutritional intake and endurance capacity are very much dependent on each other because, for energy production in the exercising muscle, an individual needs both adequate amount of glycogen stores in the muscle, and continuous supply of oxygen in the body, for such mechanism, a sportmen need to develop a sound aerobic capacity VO2max (one of the most influencing factor determining endurance capacity), which enables the body to maximize the oxygen uptake and helps in continuous supply of oxygen during energy production in exercising muscles. Hence, during relatively high work loads, the elevation of liver and muscle glycogen stores to approximately twice the normal level which has been shown to improve the endurance performance (Karlsson, 1971).

2.3.1 Carbohydrate and endurance capacity

Costill *et al.* (1985), determined the muscle glycogen utilization during prolonged exercise on successive days. Five moderately trained runners ran 16.1 km at ~80 per cent maximal O2 uptake (VO2max) on 3 consecutive days. During the study period, the subjects consumed a diet containing 40-60 per cent of carbohydrate, subjects were unable to completely resynthesize the glycogen that was utilized during exercise on any of the days, and pre-exercise muscle glycogen concentration was reduced by 50 per cent by the 3^{rd} day. This suggest that consecutive day of intense running while consuming a diet containing a moderate amount of carbohydrate can severely diminish muscle glycogen stores.

Coyle *et al*. (1983) determined the carbohydrate feeding during prolonged strenuous exercise can delay fatigue. Ten cyclists performed 2 bicycle ergo meter exercise test 1 wk apart. The point of fatigue was defined as the time at which subjects decrease the exercise intensity below their initial work rate. During one exercise test subjects were fed a glucose polymer solution beginning 20 min after the onset of exercise; during other they were given a placebo. Blood glucose concentration was 20-40 per cent higher during the exercise after carbohydrate ingestion than during the exercise without carbohydrate feeding. Fatigue was postponed by carbohydrate feeding in 7 of the 10 subjects. The time to fatigue for 10 subjects averaged 134 $\pm$ 6 min without and 157 $\pm$ 5 min with carbohydrate feeding.

Stanko *et al.* (1990) determined whether there is increase in leg exercise endurance with a high carbohydrate diet and Di Hydroxyl Acetone and Pyruvate (DHAP) in 8 trained athletes (20-30 yrs). During 7 days before exercise, a high carbohydrate diet was consumed (70% CHO). One hundred gram of DHAP (treatment) was substituted for a portion of carbohydrate. Each diet was separated by 7-14 days. After each diet cycle ergo meter exercise to exhaustion was performed whole leg arterio venous glucose difference was greater for DHAP than for placebo at rest (0.36 $\pm$ 0.05 vs.0.19 $\pm$ 0.07mM) and after 30 min of exercise (1.06 $\pm$ 0.14 vs. 0.65 $\pm$ 0.10mM) but did not differ at exhaustion. Feeding of DHAP for 7 days in conjugation with a high carbohydrate diet enhanced leg exercise endurance capacity by increasing glucose extraction by muscle.

Sherman *et al.* (1991) determined the effect of consuming two different amounts of liquid carbohydrate 1 hr before exercise on the metabolic responses during exercise and on exercise performance. Subjects consumed either 1.1g (low carbohydrate) or 2.2 g (high carbohydrate) per kg body weight or placebo (P). Subjects cycled at 70 per cent VO2max for 90 minutes, and underwent performance trial. Blood glucose and insulin responses during exercise were different among the 3 trials. Total carbohydrate trial compared to placebo trial, performance was significantly improved by low and high carbohydrate trial.

Williams *et al.* (1992) examined the influence of a carbohydrate diet on running performance of 12 men and 6 women during 30-km treadmill time trial, without modifying their food intake (trial 1). The runners were then randomly assigned to a control or carbohydrate group. The carbohydrate group supplemented their diet with additional carbohydrate with confectionary products, during 7 days before trial 2; the control group matched the increased energy intake of the carbohydrate group by consuming additional fat and protein. The mean carbohydrate intake of both group was 334 (22) g before trial 1, after which carbohydrate group consumed 556 (29) g/day for first 3 days and 452 (26) g/day for the remaining 4 days of recovery, Although there was no overall difference between the performance times for the two groups during trial 2 the carbohydrate group ran faster during the last 5 km of trial 2 than during trial 1 [3.64 (0.24) m/s vs. 3.44 (0.26) m/s]. whereas there was no such improvement in times of the men in the control group. Blood glucose concentrations of both groups decreased below pre-exercise values during trial 1, but only the control group had a decrease in blood glucose concentrations during trial 2.These results confirm that dietary carbohydrate loading improves endurance performance during prolonged running and that confectionery can be used as an effective means of supplementing the normal carbohydrate intake in preparation for endurance races.

Anderson *et al.* (1994) determined the consumption of a food with moderately high glycemic index (HGI) oat meal (GI=77) on exercise to fatigue in 9 male cyclist in comparison with glucose (GI=100). The subjects cycled for 3 trials at 75-80 per cent VO2max. Endurance time in placebo trial (66 $\pm$ 6min) was not significantly different from either oat meal or placebo trial. The mean riding time after oat meal trial was 13 per cent longer than the mean riding time after consumption of placebo.

El-Sayed *et al.* (1997) examined the effect of carbohydrate (CHO) ingestion improves endurance performance during 1h simulated cycling time trial. Eight male cyclist (VO2 peak=66.5 ml/kg/min) performed two 1 hour rides (separated by 7 days) and were fed either 80 per cent carbohydrate (CHO) or placebo solution. The beverage were administered 25min before (4.5 ml/kg) and after the end (4.5 ml/kg) of the ride. Plasma glucose increased significantly at 15 and 30 min of recovery, and was significantly higher at 30 min during the CHO trial compared with placebo. Mean power out put was significantly greater during CHO compare to placebo trial. The greater distance covered in the CHO compared with a placebo trial (41.5-1.06 and 41.0-1.06 km, respectively) was equivalent to a 44 second improvement.

Andrews *et al.* (2003) examined the effect of carbohydrate augmentation on endurance performance and substrate utilization in aerobically trained women. Eight endurance trained women (20-40 yrs) completed a 24.2 km (15 min) self spaced tread mill performance run under 3 conditions. CHO supplementation (S), CHO loading and supplementation (L+S), and placebo (P). A 6 per cent carbohydrate electrolyte solution (S +L +S) or (P) was ingested pre-exercise (6 ml/kg) and every 20 min during exercise (3 ml/kg). blood glucose was significantly higher in L + S, S and P. blood glycogen was significantly lower during L + S and S than P. performance times were 132.5 $\pm$ 6.3min (S), 134.4 $\pm$ 6.3 min (L + S), and 136.6 $\pm$ 7.9 min (P). The proportion of CHO (%) utilization was significantly higher during L + S (71.3 $\pm$ 3.8%) and S (67.3 $\pm$ 4.3%) than P (59.2 $\pm$ 4.6%).

Utter *et al.* (2004) investigated the relationship between CHO energy substrate on the perception of exertion during prolonged running. Sixteen experienced marathoners ran on tread mill for 3 h at ~70 per cent VO2max on 2 occasions while receiving 1 litre/hr carbohydrate (C) or placebo (P) beverage. The oxygen consumption during 3-hr tread mill run averaged 30.9 $\pm$ 0.9 ml/kg/min in the C and P conditions, respectively. The respiratory exchange ratio and carbohydrate oxidation rates were significantly greater in the C than P condition. Lower Rate of Perceived Exertion (RPE) was associated with a higher carbohydrate oxidation, i.e. 2.1 $\pm$ 0.1 g/min in C and 1.5 $\pm$ 1 g/min in P condition, and at the end RPE in C and P condition were 13.3 $\pm$ 0.5 g/min and 14.2 $\pm$ 0.5 g/min respectively.

Meti and Saraswathi (2006) conducted a study to show an impact of CHO supplementation on performance of 30 male high school foot ball players, 15 each from two different schools, representing experimental and control group. Three days prior to match experimental group was provided with 72 g of CHO in the form of ladu along with their daily diet. Physical performance improved significantly in experimental group i.e. rating for strength (41.3 $\pm$ 6), agility (10.1 $\pm$ 0.8) and endurance (1268 $\pm$ 197) were higher when compared with control group i.e. (33.9 $\pm$ 8), (11.1 $\pm$ 0.70) and (1268 $\pm$ 197) respectively. Experimental group was superior to the control group and experimental group won the match against the control group.

As the most efficient fuel for the exercising muscle, carbohydrate is the primary source of energy during high and low intensity activities. Above studies confirms the major role of carbohydrate in endurance (aerobic) exercise and most of the evidence supports its importance for both strength and power events. Hence use carbohydrate in sports supplements is common practice across wide variety of sports discipline. However, new research from leading exercise science laboratory is showing that sports supplement that contain protein in right balance with CHO can delay fatigue even longer than a sports supplement that only has carbohydrate.

Saundrers *et al.* (2004), studied the effects of a carbohydrate-protein (CHO+P) beverage on cycling endurance and muscle damage. Fifteen male cyclists [VO2 peak = 52.6 $\pm$ 10.3 ml (middle dot) kg-1(middle dot) min-1] rode a cycle ergo meter at 75 per cent VO2 peak to volitional exhaustion, followed 12-15 hour later by a second ride to exhaustion at 85 per cent VO2 peak. Subjects consumed 1.8 ml [middle dot] kg-1 body weight of randomly assigned carbohydrate (CHO) or CHO+P beverage every 15 min of exercise, and 10 ml [middle dot] kg-1 body weight immediately after exercise. Beverages were matched for carbohydrate content, resulting in 20 per cent lower total caloric content per administration of CHO beverage. Subjects were blinded to treatment beverage and repeated the same protocol seven to 14 days later with the other beverage. In the first ride (75% VO2 peak), subjects rode 29 per cent longer ($P < 0.05$) when consuming the CHO + P beverage (106.3 $\pm$ 45.2 min) than the CHO beverage (82.3 $\pm$ 32.6 min). In the second ride (85% VO2 peak), subjects performed 40 per cent longer when consuming the CHO + P beverage (43.6 $\pm$ 12.5 min) than when consuming the CHO beverage (31.2 $\pm$ 8.7 min). There were no significant differences in exercising levels of [latin capital V with dot above]O2, ventilation, heart rate, rate of perceived exertion, blood glucose, or blood lactate between treatments in either trial. A carbohydrate beverage with additional protein calories produced significant improvements in time to fatigue and reductions in muscle damage in endurance athletes.

2.3.2 Protein and endurance capacity

Recent research has found that the addition of protein (PRO) to a carbohydrate (CHO) supplement can further prolong sub-maxial exercise duration CHO + PRO sports supplements are suggested to improve exercise duration by increasing the rate of glucose oxidation and muscle glycogen resynthesis during exercise and also during recovery. Parry-Billing *et al.* (1990) found that soy protein foods are good source of amino acids like leucine, iso leucine, valine and glutamine which are used as energy source during exercise. Haussinger *et al.* (1994) determined that glutamine promotes protein synthesis and improves immune function and for sportsmen it helps to maintain adequate hydration in cells and buffers the lactic acid that builds up during exercise. These functions of glutamine help to support performance and recovery.

Henrikson (1995) reported, enhanced insulin sensitivity for glucose and glycogen synthesis in trained individuals, which accompanied a decrease in the insulin response during oral glucose load. Consequently even small change in plasma insulin concentration may change in plasma insulin concentration may be sufficient to promote glycogen sparing during low intensity exercise when carbohydrate (CHO) was administered as a CHO + Protein (PRO) supplement. Husaini *et al.* (1998) from the Nutrition Research and Development Centre in Indonesia recently demonstrated that young men and female elite badminton players were given a soy protein-based, nutrient rich beverage compared to a carbohydrate beverage to control group, had improved levels of VO2max and plasma iron status. The greatest improvement in VO2max was seen after four months of consuming the soy protein based beverage, and there was also an increase in physical strength and performance. It has been also suggested by Wagenmaker (1998) that an increase availability of amino acid during exercise, and in particular glutamate, may play a central role in the energy metabolism of the exercising muscle through expansion of the tricarboxylic acid (intermediate pool of Krebs cycle).

Tipton *et al.* (2001) gave a mix of essential amino acid with carbohydrate to athletes prior to immediately post and 1 hour after exercise. They found increased rates of amino acid uptake by muscle when supplementation was given prior to exercise; increases were related to elevated muscle blood supply as a consequence of the exercise. Koopman *et al.* (2004) found that supplementation of CHO+PRO during exercise has been found to decrease the endogenous protein oxidation and increase the rate of protein balance. Increased availability of amino acid will also help by limiting the break down of muscle protein during prolonged exercise, there by attenuating muscle damage (Saunders *et al*., 2004).

Recently, a study has reported that consuming a protein and CHO beverage during exercise increased performance as compared to CHO alone (Saunders *et al*., 2004). In the study exercise time to fatigue was measured in trained cyclists using a randomized double-blind repeated measures design. In experiment, subjects ingested a 7.75 per cent CHO solution on one occasion and a drink that contained 7.75 per cent CHO plus an additional 1.94 per cent protein on another occasion. Subjects cycled at 85 per cent peak VO2max immediately after performing 3 hours of standardized cycle exercise. It was reported that CHO supplementation increased time to exhaustion compared to placebo (mean: 19.7 vs. 12.7min), and the ingestion of protein with CHO further enhanced performance (26.9 min) compared to both CHO alone and placebo.

Hence, it can be understood by above studies that both carbohydrate and protein play a meaningful role in an athlete's life to achieve their peak performance. The intake of dietary sports supplements which are rich in carbohydrate and protein is very essential for an athlete to enhance their efficiency during exercise, sports performance and for a faster recovery. However, they should be viewed as supplements to the diet, not replacements for a good diet. This can help augment the normal diet to help and optimize the performance.

2.4 CONCEPTS OF SPORTS SUPPLEMENTS

Sports supplements are the highly refined foods, derived from natural sources, they come in a variety of formats, including powders, liquids, capsules, tablets and snack bars. Kristiansen (2005) reported that, based on over 450 university students both athletes and controls, identified the fact that over 90 per cent of the group consumed dietary supplements. Males commonly consumed sports drinks and products including carbohydrate gels, protein powder and creatine more than women.

A sports supplement help a sportsmen to improve the efficacy of exercise and enhance recovery from exercise, and also allows an individual to tolerate heavy training, to a greater degree by helping them to recover faster. Sports supplements are considered as ergogenic aids as they potentially improve the training adaptations. Incorporation of good sports supplements as an ergogenic aid as a part of training program is one way to help in optimizing training adaptation and preventing over training.

Antonio *et al*. (2001) reported that, numerous ergogenic aids that claim to enhance sports performance are used by amateur and professional athletes. Approximately 50 percent of the general population have reported to use some form of dietary supplements, while 76 to 100 per cent of athletes in some sports are reported to use them. Common ergogenic aids include anabolic steroids, which increase muscle mass. These illegal supplements are associated with a number of serious adverse effects and some have irreversible effects. Creatine modestly improves athletic performance and appears to be relatively safe. Dehydroepiandrosterone and androstenedione do not improve athletic performance but, apparently have similar adverse effects as testosterone and are also banned by some sports organizations. Caffeine has mild benefits and side effects and is banned above certain levels. Products that combine caffeine with other stimulants (e.g., ephedrine) have been linked to fatal events. Protein and carbohydrate supplementation provides modest benefits with no major adverse effects, hence there is an increasing focus on nutrient dense sports supplementation as an alternative ergogenic mean to enhance muscular mass and strength.

Schroder *et al.* (2004) determined the type, frequency and amount of dietary supplement consumption among a group of professional basketball players. The type, amount and specific timing of supplement use were recorded by 55 professional basketball players from seven different teams of the First Spanish Basketball League. Most participants (58%) consumed dietary supplements. Multivitamins and vitamins were the most frequently used supplements among the athletes (50.9%), followed by sport drinks (21.8%), miscellaneous supplements (21.8%), amino acids (14.5%), proteins (12.7%) and carbohydrates (12.7%). The average daily dietary supplement was one capsule of multivitamins, one capsule of antioxidant vitamins, 0.2-1.0 g vitamin C, 10.3 g protein, 1.9 g amino acids, 16.2 g carbohydrates and 377 ml of a commercial sport drink. Although the proportion of participants who consumed dietary supplements before, during and immediately after exercise was 25.4 per cent, 16.3 per cent and 7.3 per cent respectively, only a few consumed a potentially ergogenic supplement at these times. It would appear unlikely that the type or amount of dietary supplements consumed had a beneficial effect on the physical performance of these professional basketball players, with the possible exception of antioxidant vitamins and the commercial sport drinks.

Since the time immemorial, carbohydrate was known to provide instant source of energy. Much of the earlier research had focused on the use of carbohydrate as a supplemental fuel but, studies have shown that, although carbohydrate is an important source of metabolic fuel during exercise, but cannot be used as a sole supplement mainly because of its stimulatory influence on insulin.

Hawley *et al.* (1997) suggests that endurance performance is improved when athletes consume a substantial amount of carbohydrate supplement 1-2 hours before exercise. The carbohydrate supplement most suited to pre-exercise eating are choices that are low-fat, low-fiber and low-moderate in protein like liquid meal supplements (Power Bar Protein Plus Powder Drink) or carbohydrate-containing sports bars (Power Bar Performance Bar).; these are less likely to cause gastrointestinal upset.

Hargreaves (2001) has given the useful strategies for the athletes to consume a substantial amount of carbohydrate in the pre-event snack and include low Glycaemic Index (GI) foods in the pre-event meal such as, pasta served with a mixed bean pasta sauce, boiled potatoes, full-cream or low-fat yoghurt, fruit smoothie made with milk or yoghurt, wholegrain cereal sandwich and porridges of flours, Soy and Linseed bread, breakfast cereal oats plus low fat milk. Moseley (2002) reported that consuming low GI carbohydrate supplements has been proposed as a clever pre-event strategy for endurance events. It is thought that low-GI foods might reduce the sudden increase in blood glucose levels prior to an event, and prevent the subsequent drop in blood glucose once exercise is commenced. In addition, a low-GI pre-event meal might provide a continued supply of energy during the exercise session.

Hence, the pre-event sports supplements includes those foods that are consumed within the few hours of the start of competition or a training session. The type of carbohydrate and protein used in sports supplement is very important aspect to be considered. Carbohydrate consumption during events lasting longer than 2 hours should be limited primarily to liquid and semi-solid sources .Hence, it will be suitable if one uses beverage prepared by carbohydrate rich cereal flours for events that last for more than one or two hours, as they helps in slow release of glucose and supplies energy through out the game and protein content of sports supplement should be approximately about 25 per cent of the carbohydrate content.

Vanalli (2003) has developed sorghum based sports food which contains sorghum flour, soy flour, sugar powder and skimmed milk powder in the ratio of 40:15:25:20 and protein calorie ratio of this product is 18, which is an ideal ratio for a sports food. Such type of supplement can be recommended for all classes of athletes, as it provides both low GI carbohydrate and a good quality protein along with a little amount of fats. Hence, the present study was undertaken to test the efficacy of this sports food on physical endurance of basket-ball players.

3. MATERIAL AND METHODS

The present study entitled "Efficacy of sorghum based supplementary sports food on physical endurance of basket-ball players" was carried out in Dharwad city during 2006-07. The details of the materials and methodology employed in carrying out the study are described in this chapter.

3.1 SELECTION OF THE SAMPLES

The study was conducted on 32 male professional basket-ball players of Dharwad city, belonging to the age group of 16-20 years. The samples were selected purposively for the study. Sixteen residential basket ball players were selected from a Sports Authority of India (SAI), Dharwad which is an government institute and another 16 basket ball players were selected from Rowers Basket ball Club Dharwad, which is a semi-government and aided institute. All the subjects were undergoing a regular practice daily for a minimum 2 hours each in the morning and evening.

3.2 INTERVIEW SCHEDULE

A detailed questionnaire was structured to collect necessary basic and sports related information of the subjects. The details of questionnaire are furnished below.

3.2.1 General information

General information such as age, education and occupation were collected by structured, pre-tested questionnaire through personal interview method.

3.2.2 Sports activity

Information about the sports activities such as experience in the field of sports, level of participation, achievements in the field and practice were collected.

3.2.3 Daily routine

Information on routine exercise pattern, resting period, sleeping times, and interest in other activities and hobbies were collected.

3.2.4 Dietary habits

Information regarding existing food habits, pattern of water consumption, number of meals or beverages consumed per day and special foods, foods consumed and avoided for optimal sports performance and frequency of consumption of different types of foods were elicited with the help of questionnaire.

3.3 ASSESSMENT OF NUTRITIONAL STATUS

The nutritional status of subjects was assessed by nutritional anthropometry, diet survey and haemoglobin estimation.

3.3.1 Nutritional anthropometry

The anthropometric measurements viz., height, weight, mid upper arm, waist and hip circumferences were recorded as per the guidelines suggested by ICMR standards. The height was measured using an anthropometric rod nearest to 0.1 cm. A portable platform balance (spring) was used to measure weight in kilogram nearest to 0.5 kg with respondents standing without support, with casual light clothing and without shoes. Mid upper arm, waist and hip circumferences were measured using a non-stretchable measuring tape in centimeters.

3.3.1.1 Body mass index (BMI)

The anthropometric data were further used far computing BMI, by the formula expressed as the ratio of weight in kg's to height in square meters.

$$\text{BMI} = \frac{\text{Weight (kg)}}{(\text{height})^2 \text{ mt}}$$

Further individuals were classified into different classes based on WHO (2002) classification for Asian adults.

BMI classification for Asian adults (WHO, 2002)

BMI classes	Presumptive diagnosis
< 18.5	Under weight
18.5 – 22.9	Ideal BMI
> 23.0	Over weight
> 25.0	Obese grade I
> 30	Obese grade II

3.3.1.2 Waist to hip ratio (WHR)

The abdominal obesity was judged by waist to hip ratio (Lean *et al.*, 1995).

Male > 0.95 was considered as obese.

3.3.2 Diet survey

Diet survey was conducted to eliciting the information regarding dietary habits, through 24 hours dietary recall method and by computing the adequacy for both food and nutrients.

3.3.2.2 Twenty four hour recall method

Intake of food was assessed by 24 hour recall method using standardized vessels, cups and spoons and nutrient adequacy was calculated based on RDA (Recommended Dietary Allowances).

3.3.2.2.1 Food and nutrient adequacy

The per cent adequacy of an individual for 11 Food group was computed by utilizing suggested daily allowance for athletes (Satyanarayana *et al.*, 1985) and calculated by using the formula given below.

$$\text{Per cent food adequacy} = \frac{\text{Food intake}}{\text{SDA of the foods}} \times 100$$

Per cent adequacy were calculated for each of 11 food groups *viz.,* cereals, pulses, green leafy vegetables, other vegetables, fruits, milk, roots and tubers, sugar, fats and oils, meat and egg.

The raw food equivalent of cooked foods were computed from the standardized cups. The nutrient present in the food were computed from Annapurna VAR-3 a software developed by M.R. Chandrashekhar, Bangalore.

The average consumption of food items thus calculated from diet survey were further used to compute the nutrient adequacy for calories, protein, fat fiber, carbohydrates, Retinol, carotene, Ascorbic acid, vitamin B_{12}, folic acid, calcium, iron, sodium, potassium, magnesium, copper, zinc, fibre using food composition table (Gopalan and Vijayaraghavan, 1971).

Proportion of ingredients 40:15:25:20

Plate 1. Ingredients used in sports food

Plate 1. Ingredients used in sports food

$$\text{Per cent nutrient adequacy} = \frac{\text{Nutrient intake}}{\text{RDA of the nutrients}} \times 100$$

Recommended Dietary Allowances for athletes (Gopalan and Vijayaraghavan, 1971).

3.3.3 Haemoglobin assessment

The haemoglobin was assessed by Cyanmethaemoglobin method (Varley, 1976). The blood (20 µl) was drawn with the help of haemoglobin pipette. The blood was transferred on to labeled Whatman No. 1 filter paper and air dried. In the lab, the portion of the filter paper containing the blood was cut and dipped in 5 ml of Drapkins solution and kept for half an hour. Then contents were mixed by overtex mixer and colorimeter reading were taken at 540 nm and compared with standard curve to get haemoglobin values.

3.4 PROXIMATE COMPOSITION OF SPORTS FOOD

The supplementary sports food was developed in the Department of Food Science and Nutrition by Vanalli (2003). The supplementary sports food was prepared with sorghum, soybean, sugar and skim milk powder at 40:15:25:20 proportion (Plate 1). The product was organoleptically highly acceptable and Protein Energy Ratio of this product was 18 which adhere to cater the needs of a sportsmen.

3.4.1 Moisture

Five grams of sports food sample was weighed into a previously weighed moisture cup and dried in an oven at 60°C till a constant weight was attained (Anon., 1990).

$$\text{Moisture (\%)} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Sample weight (g)}}$$

3.4.2 Crude Protein

The nitrogen content of sports food was estimated by Microkjeldhal method in Paranas and Wagner apparatus (Anon., 1990). The crude protein content was calculated by multiplying with factor 6.25 and expressed on per cent basis.

$$\text{Protein (\%)} = \frac{\text{(Titrate – Blank)} \times \text{Normality of HCl} \times 14.007 \times 6.25}{\text{Sample weight (g)}} \times 100$$

3.4.3 Crude fat

Moisture free sample was weighed in moisture free thimble and crude fat was extracted by refluxing in soxhlet apparatus using petroleum ether as solvent. Per cent crude fat was calculated by difference method (Anon., 1990).

$$\text{Crude fat (\%)} = \frac{\text{Initial weight (g)} - \text{Weight after extraction (g)}}{\text{Sample weight (g)}} \times 100$$

3.4.4 Crude fiber

Fat free flour sample was hydrolyzed with dilute sulphuric acid (0.255 N) and dilute alkali (0.313 N) to estimate crude fiber by employing the methods Mayanard (1970).

$$\text{Crude fiber} = \frac{\text{Weight of residue with crucible} - \text{Weight of ash with crucible}}{\text{Weight of fat free sample (g)}} \times 100$$

3.4.5 Carbohydrate

The carbohydrate content was calculated by difference method i.e. deducting the sum of the value for moisture, crude protein, crude fat and crude fiber in 100 (Raghuramulu *et al*., 1983).

3.5 CHARACTERIZATION OF SENSORY PROFILE OF SPORTS FOOD

3.5.1 Laboratory level

Characterization of sports food at laboratory level was done by developing a score card which consisted of the parameters like colour and appearance, texture, taste and aroma. Sports food as such was given to 10 trained panel members and were asked to define and characterize each parameter separately (Appendix II).

3.5.2 Consumer level

The score card on 9 point Hedonic scale was used for organoleptic evaluation at consumer level which was based mainly on the colour and appearance, texture, taste, aroma and overall acceptability (Appendix III). The sports food as such was given to 100 sports athletes for organoleptic evaluation, who were randomly selected from a sports school called Chandargi Sports School near Belgaum district.

3.6 EFFICACY TEST

Endurance capacity of all the subjects were tested on a motorized tread mill machine. A preliminary test on tread mill was taken from all the subjects (Plate 2) to familiarize the machine and to set a speed limit *i.e.* An average value for speed was calculated and was set to 6 km hour. This value for speed was fixed for further tests. The parameters, time of exhaustion, distance covered and calories burnt were noted.

3.6.2 Short term study (Fig. 1)

3.6.2.1 Loading test

The test was conducted during morning hours, all the subjects were informed to consume their regular morning break fast before coming to the experimental area, and were informed to perform selected warm up exercises for five minutes. The speed of tread mill was set to 6 km/hour based on that speed limit, subjects were informed to jog or walk on tread mill till they exhaust (Plate 2). At the end of trial, calories burnt, distance covered and time of exhaustion were recorded.

After this first protocol, subjects were given two days of rest period and were instructed to gather at the same time, consuming the same quantity and type of diet which they have consumed during the first protocol.

One hundred and fifty ml of water was heated for 4-5 minutes and 50 g of supplementary sports food was added and stirred thoroughly to get the porridge consistency. This test food was loaded to all the subjects 1 hour before the tread mill exercise (Plate 2). After one hour of loading, all the subjects were informed to perform 5 minutes warm up exercise and fatigue test on tread mill was performed (Plate 2) and the parameters like distance covered, time of exhaustion and calories burnt were recorded.

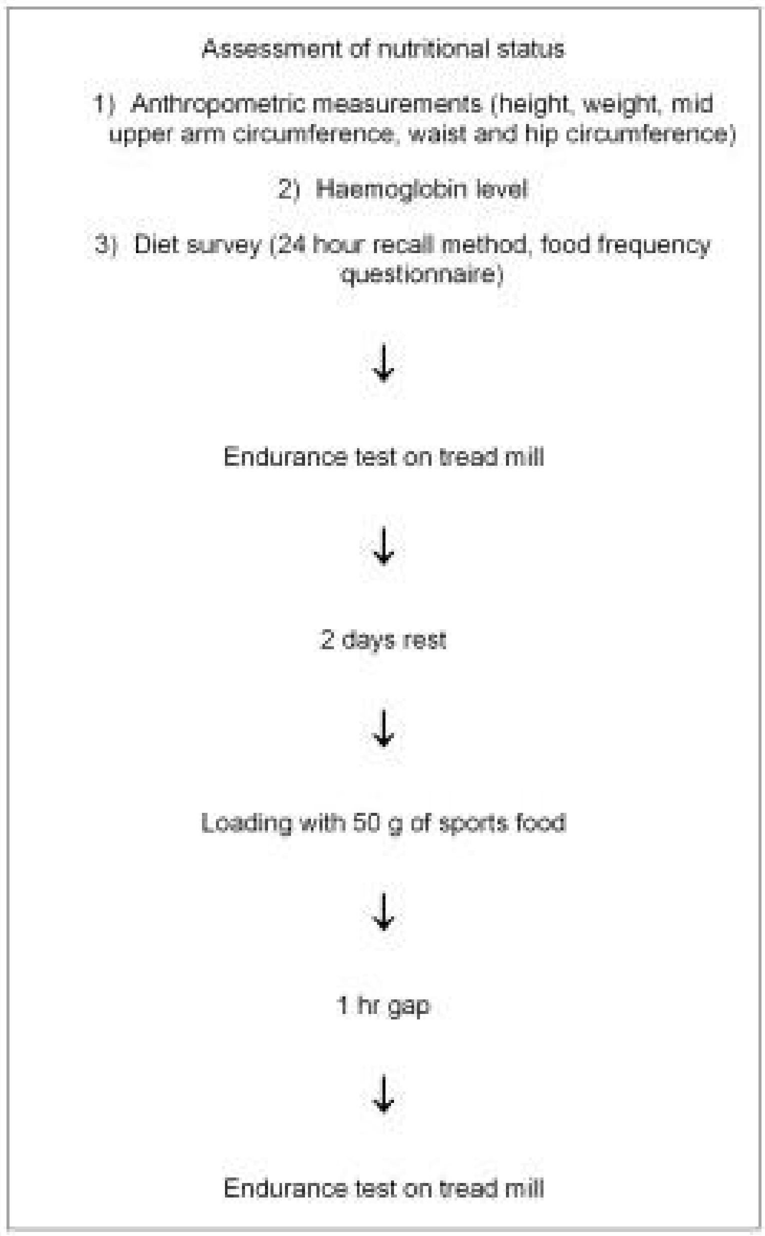
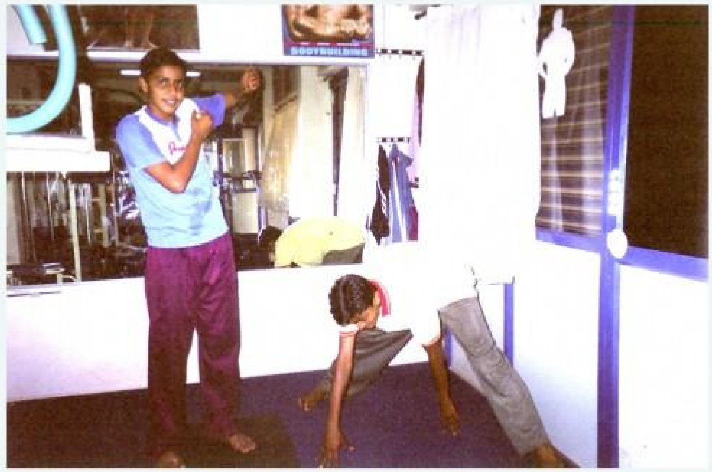


Fig. 1. Short term study (N=32)

Fig. 1. Shot term study (N=32)

Preliminary test on tread mill



Warm-up exercise

Loading with sports food

Endurance test on tread mill

Plate 2. Short-term study

Plate 2. Short-term study

3.6.3 Long term study (Fig. 2)

3.6.3.1 Intervention programme

Out of 32 subjects, 16 subjects were randomly selected as experimental group for the purpose of intervention with 50 g of test food per person per day for a period of 30 days (Plate 3). The subjects consumed the test food along with their daily diet, throughout the intervention period. Remaining 16 subjects served as control group, who were not served test food throughout the intervention period.

Before starting the intervention programme all the subjects were given de worming tablets (ARYAWORM).

3.6.3.2 Parameters observed after supplementation programme

The height, weight, mid upper arm circumference, haemoglobin level and endurance capacity were recorded in both control and experimental group before and after intervention programme.

3.7 STATISTICAL ANALYSIS

The responses of the subjects were expressed in frequency and percentages.

The paired 't' test was used to test the significance of mean difference between before and after loading trial and initial and final values of experimental and control group with respect to anthropometric parameters, haemoglobin levels and endurance capacity.

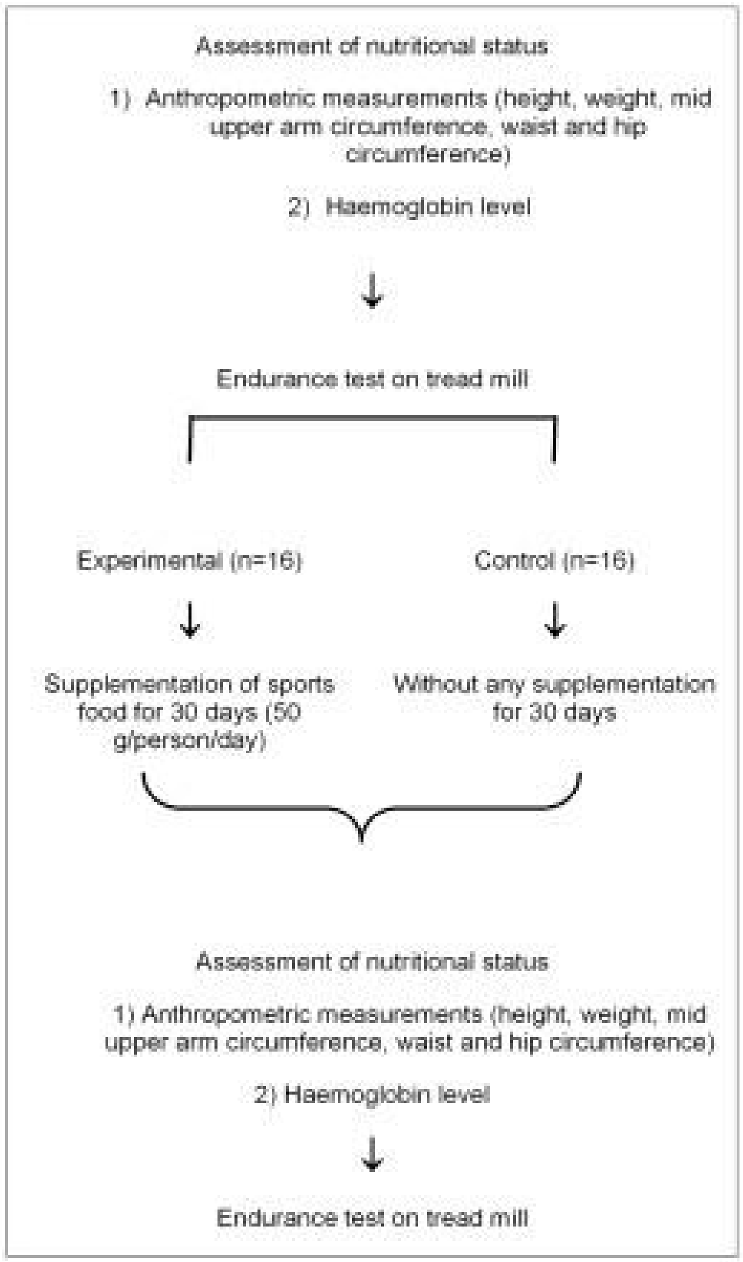


Fig. 2. Long term study (N=32)

Fig. 2. Long term study (N=32)

Plate 3. Supplementation of sports food (50 g/person/day)

Plate 3. Supplementation of sports food (50 g/person/day)

4. EXPERIMENTAL RESULTS

The results of the study conducted during 2006-07 on “Efficacy of supplementary sports on physical endurance of basket-ball players” are presented in this chapter. The results related to demographic profile, anthropometry, diet history, nutrient and food adequacy, sensory profile of sports food and endurance capacity are included in this chapter.

4.1 GENERAL CHARACTERISTICS OF BASKET-BALL PLAYERS

4.1.1 Information about age and education

The information about age and education of 32 basket-ball players, are presented in Table 1.

All the 32 basket-ball players were males and were in different age groups, more than half of the players (56%) were in between 18-21 years of age group and only 28 per cent were in 16-18 years of age. Regarding literacy level, high number of players (56%) were graduates whereas, 37 per cent were college students and 6 per cent were high school students and none of them were illiterates.

4.1.2 Information about sports activities

The data from Table 2 shows that most of the players (56%) were in the field of sports since 2-4 years followed by 25 per cent were since 4-6 years further 12 per cent were in sports activity since 6-8 years and only 6 per cent of them were in this field since 8-10 years. Most of the players (75%) were playing basketball since 2-4 years and only 21 per cent of them were playing since 4-7 years.

Majority of them (94%) had played district level games while 72 per cent of the players had played both university and state level games and 37 per cent of them have played national level games and only 15 per cent had played up to high school level games. More than half (53%) of them had got group championship 1-4 times, followed by 28 per cent players who got group championship 4-8 times and 12 per cent of the players had never got any group championship. Regarding individual achievement almost 47 per cent of the players had never got any individual medal in the game whereas, around 37 per cent of them had got individual medal 4-8 times and about 16 per cent of them had got the individual medals 4-6 times.

4.1.3 Information about duration of practice

Table 3 shows that, 56 per cent of the players were practicing basketball game 6 days a week while, few of them (31%) were practicing daily and about 12 per cent of them were practicing every alternate day.

4.1.4 Information about time spent in other games

It is clear from Table 4 that about 31 per cent of the players were interested in other games like volley ball and played this game both twice a week and once a month, while 53 per cent of the players were interested in net ball and about 28 per cent of them were playing this game once a week and around 12 per cent were playing both twice a week and once a month, where as around 44 per cent of the players were interested in cricket and about 16 per cent of them were playing cricket both once a week and once a month followed by twice a week (12%). Twenty five per cent of the players were interested in foot ball and around 16 per cent of them played foot ball once a week and few were (9%) playing twice a week. Around 16 per cent of them were interested in hand ball and about 9 per cent of the players were playing this game once a month and around 6 per cent of them were playing twice a week.

Table 1. Distribution of subjects according to age and education

(N=32)

Sl. No.	Particulars	Frequency	Percentage
1	AGE (years)		
	16-18	9	28.12
	18-21	23	71.87
2	EDUCATION		
	High school	2	6.25
	College	12	37.50
	Graduate	18	56.25

Table 2. Information about sports activities

(N=32)

Sl. No.	Particulars	Frequency	Percentage
1	Since how long you have been in sports		
	2-4yrs	18	56.25
	4-6yrs	8	25.00
	6-8yrs	4	12.50
	8-10yrs	2	6.25
2	Experience in basket-ball game		
	2-4yrs	25	78.12
	4-7yrs	7	21.87
3	Level of participation		
	National level	12	37.50
	State level	23	72.00
	District level	30	94.00
	University level	23	72.00
	High school level	5	15.60
4	Group championship		
	1-4	17	53.12
	4-8	11	34.37
	never	4	12.50
5	Individual medal		
	1-4	12	37.50
	4-6	5	15.62
	Never	15	46.87

Table 3. Time spent by the players for practicing basket-ball (weekly)

(N=32)

Practicing basket-ball	Frequency	Percentage
Daily	10	31.25
6-days a week	18	56.25
Every alternate day	4	12.50

Table 4. Time spent in other games (weekly)

(N=32)

Games	Twice-a-week		Once a week		Once a month	
	F	P	F	P	F	P
Net ball	4	12.50	9	28.12	4	12.50
Volley ball	10	31.25	10	31.25	-	-
Foot ball	3	9.30	5	15.62	-	-
Hand ball	2	6.25	3	9.37	-	-
Cricket	4	12.50	5	15.62	5	15.62

F – Frequency, P - Percentage

4.1.5 Information about daily exercise

The data collected on routine exercise habits are presented in Table 5.

All the 32 basket-ball players were performing exercises like jumping, stepping, sprints, jogging since 1-2 years and majority (94%) of them were practicing deeps and jogging since 1-2 years. Most of them were performing sit-ups (78%) and some (47%) of them were performing exercises like bench press, shoulder press ,knee extension ,knee curl, and bicep curl since 1-2 years. While, few regular warm up exercises were practiced by all the basket-ball players since 2-3 years. Almost 25 per cent were performing both bench press and shoulder press exercise since 2-3 years followed by knee curl (22%), bicep curl (19%), knee extension (16 %), sit ups (12%), and deeps (6 %). Majority of the players were (78%) practicing jumping exercise for 5-10 minutes per day followed by sit ups (56%) and around 47 per cent of them were practicing bench press, shoulder press, knee extension, knee curl, and bicep curl for 5-10 minutes per day followed by deeps (31%), warm-ups (28%). Most of the players (62%) were practicing stepping exercise for 15-30 minutes per day followed by deeps (47%), sprints (31%), warm-ups (22%), jogging (12%) and sit ups (6%), further around 87 per cent of the basket-ball players were jogging for 30-60 minutes per day, while 50 per cent of them were performing warm up exercises, and 25 per cent were practicing sprints for 30-60 minutes per day. All the basket-ball players were practicing warm ups, deeps, jumping, and stepping exercises both in the morning and evening times, and around 94 per cent of the players were practicing sit up exercise during morning followed by jogging (62%) and sprints (56%) while exercises like bench press, shoulder press, knee extension, knee curl and bicep curl were practiced by about 47 per cent of the players in the morning times. And during evening times most of them were practicing sit ups (62%) and about 44 per cent of them were going for jogging.

4.1.6 Time spent for sleep

The results of time spent for sleep is presented in the Table 6. At night almost 62 per cent of the players were sleeping for 6-8 hours and around 31 per cent of them were sleeping for 5-6 hours and few of them (6%) were sleeping for 8-10 hours. In the noon, most (62%) of them were taking rest for 1-2 hours and 25 per cent of them were taking rest for 2-3 hours and 12 per cent of them were not in the habit of sleeping during day time.

4.2 INFORMATION ABOUT FOOD HABITS

4.2.1 Distribution of the basket-ball players according to their consumption of morning beverages

It is clear from Table 7 that more than half of the (56%) basket-ball players preferred tea as their morning beverage and about 37 per cent of them were drinking tea 1-2 times per day followed by those (19%) drinking 2-4 times per day and few (9%) of them preferred 4-6 time per day whereas, around 22 per cent of the players preferred milk as their morning beverage and about 78 per cent of them were drinking 1-2 glasses of milk per day. Fruit juices were consumed as morning beverage by about 15 per cent of the players and half of them (50%) preferred to consume 1-2 glasses of fruit juices per day. Only few (6%) of them preferred coffee as their morning beverage and were consuming 1-2 cups of coffee per day.

4.2.2 Special foods consumed by the basket-ball players

Special foods consumed by the basket-ball players are given in the Table 8. Majority of the players were consuming banana as a special food for sports and almost 56 per cent of them were consuming 1-2 bananas in the morning and 25 per cent of them preferred to consume at night. Whereas, about 16 per cent of them were consuming 2-4 and 4-8 bananas in the morning. During night time, 50 per cent of the basket-ball players were consuming 200-300 ml of milk as their special food for sports and around 47 per cent of them preferred during morning hours. Whereas, 12 per cent of the players were consuming 300-500 ml and 6 per cent of them were consuming 500-1000 ml of milk during morning hours. Further, 50 to 100 g of soaked bengal gram were consumed by 47 per cent of the basket-ball players during morning hours. And around 16 per cent of them were consuming *badam* milk as their special food for sports during night time. Further, 47 per cent of them were consuming 40-60 g of almond nuts in the evening as their special food for sports followed by 16 per cent who preferred at night time, and another 16 per cent of them were consuming 40-50 g of almond nuts during morning hours.

Subsequently, around 25 per cent of the basket-ball players were consuming 20-40 g of cashew nuts as special food for sports during night time followed by 19 per cent who consumed during morning hour. Around 16 per cent were consuming 40-50 g of cashew during morning hours. Raisins were consumed as special food for sports by 34 per cent of them during morning hours, further 25 per cent of them were consuming 20-40 g of dates in the evening followed by 16 per cent who consumed at night time and few (9%) of them were consuming during morning hours. About 16 per cent of the basket-ball players were not in a habit of consuming any special food for sports as such.

4.2.3 Foods consumed during events

It is noticed from Table 9 that most of the (62%) basket-ball players consumed *idli* before the start of event and around 56 per cent of them consumed banana followed by bread sandwiches (47%), fruit juice (37%), biscuits (22%), and 6 per cent of them did not consume any thing before the start of event.

During events, 62 per cent of the basket-ball players consumed glucose followed by electrolyte (62%), fruit juices (47%) and 9 per cent of them did not consume any thing during events. After events around 56 per cent of the players consumed *lassi*, milk shakes and fruit juices followed by glucose (44%), coconut water (34%), chocolates (31%), biscuits (25%) and around 9 per cent of them did not consume any thing immediately after event, where as heavy meals were consumed by some (6%) of them few hours after finishing the game.

4.2.4 Foods avoided

Foods avoided by the basket-ball players during events are listed in Table 10. All the 32 basket-ball players avoided heavy meals and fried foods before events and 92 per cent of them avoided spicy foods followed by junk foods (47%), milk (41%), and rice (31%), non-vegetarian (16%) foods while, 12 per cent of the basket-ball players avoided egg before events. During events 31 per cent of them avoided drinking ice water and 25 per cent of them avoided soft drinks whereas, after events 31 per cent of the players avoided fried and spicy foods.

4.2.5 Water consumption

It is evident from Table 11 that, before the start of the event around 78 per cent of the basket-ball players preferred to drink 100-150 ml and 22 per cent of them preferred to drink 50-100 ml of water. During the events around 53 per cent of them preferred to drink 150-200 ml of water followed by 100-150 ml (47%), further 25 per cent of them preferred to drink 200-250 ml. After the events 84 per cent of the basket-ball players preferred to drink 1000 ml followed by 500 ml (37.5%) and ad libitum (31.25 %) water after events.

4.3 NUTRITIONAL STATUS OF BASKET BALL PLAYERS

4.3.1 Based on anthropometry and biochemical parameters

4.3.1.1 Mean anthropometric and biochemical values

The mean anthropometric measurements of basket-ball players are depicted in Table 12. The mean height of the basket ball players was 183.34 cm and mean body weight was 70.21 kg with a mean BMI of 20.82. The mean values for waist and hip circumferences were 79.6 cm and 90.65 cm respectively; and mean waist-to-hip ratio was 0.82. The mean value for mid-arm circumference of basket-ball players was 27.9. The mean hemoglobin level of the basket-ball players was 13.88 g/100 ml.

4.3.1.2 Distribution of the basket-ball players according to BMI

The data on classification of basket-ball players based on BMI is presented in Table 13 and it is clearly noticed that around 66 per cent of the players were in the normal category, by having BMI between 18.5-22.9. About 19 per cent were under weight by having BMI <18.5. Around 9 per cent of them were over weight *i.e.*, a BMI >23, followed by obese grade I who were around 6 per cent having BMI >25.

Table 5. Information about exercise pattern of basket-ball players

(N= 32)

Particulars	Period of practice (yrs)				Time spent/day(min)						Frequency/day			
	1-2		2-3		5-10		15-30		30-60		Morning		Evening	
	F	P	F	P	F	P	F	P	F	P	F	P	F	P
Warm-ups	-	-	32	100	9	28.12	7	21.87	16	50.00	32	100	32	100
Jogging	32	100	-	-	-	-	4	12.50	28	87.50	20	62.50	14	43.70
Jumping	32	100	-	-	25	78.12	-	-	-	-	32	100	32	100
Stepping	32	100	-	-	-	-	20	62.50		-	32	100	32	100
Sprints	32	100	-	-	-	-	10	31.25	8	25.00	18	56.25	32	100
Deeps	30	93.75	2	31.25	10	31.25	15	46.87	-	-	32	100	32	100
Sit-ups	25	78.12	4	12.50	18	56.25	2	6.25	-	-	30	93.75	20	62.50
Bench press	15	46.87	8	25.00	15	46.87	-	-	-	-	15	46.87	-	-
Shoulder press	15	46.87	8	25.00	15	46.87	-	-	-	-	15	46.87	-	-
Knee extension	15	46.87	5	15.62	15	46.87	-	-	-	-	15	46.87	-	-
Knee curl	15	46.87	7	21.87	15	46.87	-	-	-	-	15	46.87	-	-
Bicep curl	15	46.87	6	18.75	15	46.87	-	-	-	-	15	46.87	-	-

F – Frequency, P – Percentage

Table 6. Duration of sleep per day

(N=32)

Night time			Day time		
Time (hour)	Frequency	Percentage	Time (hour)	Frequency	Percentage
5-6	10	31.25	1-2	20	62.50
6-8	20	62.50	2-3	8	25.00
8-10	2	6.25	0	4	12.50

Table 7. Distribution of subjects according to their consumption of morning beverages

(N=32)

Particulars	Tea		Coffee		Milk		Juice	
Morning beverages	F	P	F	P	F	P	F	P
No of cups per day	18	56.25	2	6.25	7	21.87	5	15.25
1-2	12	37.5	2	6.25	25	78.12	16	50.00
2-4	6	18.75	-	-	-	-	-	-
4-6	3	9.37	-	-	-	-	-	-

F – Frequency, P - Percentage

Table 8. Special foods consumed by the subjects

(N=32)

Particulars	Morning		Evening		Night	
	F	P	F	P	F	P
Milk(ml)						
200-300	15	46.87	7	21.87	16	50.00
300-500	4	12.50	-	-	-	-
500-1000	2	6.25	-	-	-	-
Soaked bengal gram (g)						
50	10	31.25	-	-	-	-
Badam milk (ml)						
200-300	-	-	-	-	5	15.62
Almond nuts (g)						
40-60	10	31.25	15	46.87	5	15.62
60-80	5	15.62	-	-	-	-
Cashew nuts (g)						
20-40	6	18.75	-	-	8	25.00
40-50	5	15.62	-	-	-	-
Raisins (g)						
10-20	11	34.37	-	-	-	-
Dates (g)						
20-40	3	9.37	8	25.00	5	15.62
Banana (no.)						
1-2	18	56.25	-	-	8	25.00
2-4	5	15.62	-	-	-	-
4-8	5	15.62	-	-	-	-
Not taking any special foods	5	15.62				

F – Frequency, P - Percentage

Table 9. Foods consumed during events

(N=32)

Foods	Before event		During event		After event	
	F	P	F	P	F	P
Idli	20	62.50	-	-	-	-
Sandwitch	15	46.87	-	-	-	-
Biscuits	7	21.87	-	-	8	25.00
Chocolates	-	-	-	-	10	31.25
Banana	18	56.25	-	-	-	-
Boiled potato	3	9.37	-	-	-	-
Lassi	-	-	-	-	27	84.37
Milk shake	-	-	-	-	18	56.25
Glucose	-	-	27	84.37	14	43.75
Fruit juice	12	37.50	15	46.87	9	28.12
Electrolytes	-	-	20	62.50	-	-
Coconut water	-	-	-	-	11	34.37
Heavy meals	-	-	-	-	2	6.25
Nothing	2	6.25	-	-	-	-

F – Frequency, P - Percentage

Table 10. Foods avoided during events

(N=32)

Foods	Before event		During event		After event	
	F	P	F	P	F	P
Heavy meals	32	100	-	-	27	84.37
Fried foods	32	100	-	-	10	31.25
Spicy foods	29	90.62	-	-	10	31.25
Rice	10	31.25	-	-	-	-
Egg	4	12.50	-	-	-	-
Non vegetarian foods	5	15.62	-	-	-	-
Junk foods	15	46.87	-	-	-	-
Milk	13	40.62	-	-	-	-
Ice water	-	-	10	31.25	-	-
Soft drinks (carbonated)	-	-	8	25.00	-	-

F – Frequency, P - Percentage

Table 11. Information about water consumption

(N=32)

Quantity (ml)	Before event		During event		After event	
	F	P	F	P	F	P
50-100	7	21.87	-	-	-	-
100-150	25	78.12	15	46.87	-	-
150-200	-	-	17	53.12	-	-
200-250	-	-	8	25.00	-	-
500	-	-	-	-	12	37.50
1000	-	-	-	-	27	84.37
Adlibitum	-	-	-	-	10	31.25

F – Frequency, P - Percentage

4.3.2 Based on diet survey

4.3.2.1 Mean intake and per cent adequacy of food by basket-ball players

Mean food intake of the basket-ball players is presented in the Table 14 and depicted in Fig.3. Mean intake of cereals by the players was 439 g which was below the SDA (Suggested dietary allowance) level (550 g) with mean per cent adequacy of 80 per cent where as adequacy was 198 per cent for pulses as the intake was 79 g which was above the SDA level (40 g). With regard to green leafy vegetables and other vegetables the mean intake (10.85 g and 83.62g) was below the SDA level (150 g and 200g) with mean per cent adequacy around 7 per cent and 42 per cent respectively. The mean per cent adequacy for roots and tubers was around 68 per cent with mean intake of 102 g which was below the SDA level (150 g).

The mean intake of fruits was around 136 g per cent with a mean per cent adequacy of around 124 per cent, as it was below the SDA level (150 g). The SDA for milk was 750 ml but the mean intake of milk by the players was about 566 ml with an adequacy of 75 per cent. The mean intake of fats and oils (90 g) and sugar (95.70 g) were above the SDA level (50 g and 80 g) with mean per cent adequacy of 180 and about 200 per cent respectively. The mean intake of egg was around 99 g which was below the SDA level (100 g) with mean per cent adequacy of around 99 per cent, while the mean intake of meat was around 182 g with mean per cent adequacy of around 73 per cent which was below the SDA level (250 g).

4.3.2.2 Mean intake and per cent adequacy of nutrient by basket-ball players

The data on mean nutrient intake and per cent adequacy by the basket-ball players is summarized in Table 15 and shown in Fig. 4. The mean intake of energy was 3546 kcal per day which was below the RDA (4320 kcal) with the mean per cent adequacy of 82 per cent. With regard to protein, the mean intake was 95 g and the mean per cent adequacy was around 86 per cent, as the intake was below the RDA (100-120 g). The mean intake of carbohydrates by the basket-ball players was around 452 g which was below the RDA (250-1200 g) with the mean per cent adequacy of around 62 per cent.

The mean intake of vitamin A was 747.12 µg which was below the RDA level (900 µg) with mean per cent adequacy of around 83 per cent. For Vit C the adequacy was around 65 per cent as the mean intake (71 mg) was below the RDA (100-120 mg). The mean intake of follic acid, thiamine, riboflavin and niacin (385.12 mg, 2.5 mg, 2.3 mg and 22.35 mg) were below the RDA levels (400mg, 3-4 mg, 3-4 mg and 40-50 mg) with mean per cent adequacy of around 96, 71, 66 and 50 per cent respectively. Further, with regard to mineral intake, calcium and iron intake (794.58 mg and 26.11 mg) were below the RDA levels (1000 mg and 50-75 mg) with mean per cent adequacy around 79 and 42 per cent respectively; whereas, adequacy for potassium and zinc were around 97 and 92 per cent with mean intake of about 1935 mg and 10 mg which were below the RDA values *i.e.* 2000 mg and 11 mg respectively.

4.3.2.3 Food frequency

Frequency of food consumption by basket-ball players is presented in Table 16. All the 32 basket-ball players were consuming cereals, milk, cooking oil and sugar daily and around 94 per cent of the players were consuming pulses daily followed by fruits (69%), egg (62%), curds/butter milk (37%), oil seeds (34%), green leafy vegetables (31%), other vegetables (16%), chicken and jaggery (12%) while, around 9 per cent of them were consuming both butter and bakery products daily. Ice creams were consumed by around 62 per cent of the players once in 2 days. Soft drinks and chicken were consumed by almost 53 and 41 per cent of the players once in two days respectively. Further, green leafy vegetables, other vegetables and ghee (31%) were also consumed once in 2 days followed by fruits (25%), chocolates (22%), egg (16%), curds/butter milk (9%), and about 6 per cent of them consumed pulses, cheese and jaggery once in 2 days. Bakery products and oil seeds were consumed twice a week by around 37 and 34 per cent of the players respectively, followed by other vegetables (31%), curds/butter (28%), chocolates (22%), fish and jaggery (19%), butter (16%), pulses, green leafy vegetables and chicken (12%), cheese egg and ice creams (9%) while around 6 per cent of them were consuming both soft drinks and chats twice a week. Fish were consumed by 31 per cent of the players weekly once followed, by butter (28%), oil seeds (22%), chocolates and bakery products (19%), green leafy vegetables and other vegetables (16%), cheese, egg, chicken and ice creams (12%), curds/butter milk, ghee, noodles (9%) and pizza (6%). Chats were consumed by around 22 per cent of the basket-ball players fortnightly followed by meat (22%), cheese, fish, noodles (16%), chicken and green leafy vegetables (12%), curds/butter milk, ghee, jaggery, bakery products, pizza and ice creams (9%), and other vegetables and soft drink (6%). Noodles and chats were consumed once a month by around 22 per cent of the basket-ball players followed by fish (19%), meat, ghee, pizza (16%), burger and jaggery (12%), cheese (9%), ice creams and soft drinks (6%). Most (53%) of the basket-ball players were consuming noodles occasionally followed by burger, cheese, butter and ghee (31%), pizza (28%) bakery products (25%), meat (22%), jaggery (19%), fish (16%), green leafy vegetables and chats (12%), soft drinks (9 %) further, around 53 per cent of them never consumed noodles and burger (37%), ghee and egg (16%), green leafy vegetables (12%) were also never consumed. And about 3 per cent of the players never consumed cheese and meat.

4.4 SENSORY PROFILE OF SPORTS FOOD

4.4.1 Sensory profile of sports food at laboratory level

Sports food was characterized at laboratory level for parameters like colour and appearance, texture, taste, aroma. Judges have evaluated colour and appearance as very attractive, creamish, appealing, uniform. For the parameter texture, judges have characterized it as fine smooth, amorphous powder. Taste was characterized as sweetish, delicious, balanced sweet taste. Further aroma was characterized mild malted flavor.

4.4.2 Sensory profile of sports food at consumer level

Sports food was evaluated at consumer level for the parameters like colour and appearance, texture, taste, aroma and over all acceptability and results are presented in Table 17.

Among 100 samples 29 per cent of the basket-ball players have scored as excellent and extremely good for colour and appearance and 22 per cent of them have scored it as very good followed by good (10%), moderately good (6%) and only few (4%) of them have scored it as fair. For the parameter texture, 26 per cent of them have scored it as very good followed by excellent (24%), extremely good (20%), moderately good (15%), good (10%) and fair (5%). Most (52%) of them have scored excellent for the taste while 21 per cent them have scored it as extremely good followed by very good (15%), moderately good (10 %) and good (3%), further for the parameter aroma 29 per cent of them have scored it as extremely good followed by excellent (27%), moderately good (7%),very good (15%), good (5%), very fair (4%) and fair (3%). Fifty five per cent of the basket-ball players have given excellent score for over all acceptability and 20 per cent of them have given very good further 12, 10 and 3 per cent of them have given extremely good, moderately good and good respectively.

4.4.3 Nutrient composition (g/100 g) of sports food

Proximate composition *viz.* moisture, protein, fat, ash, crude fiber and total ash of sports food is given in Table 18.

The mean moisture content of sports food was 4.50 per cent, protein, fat, ash, crude fiber and carbohydrate contents were 12.65, 3.47, 2.84, 1.5 and 75.04 per cent respectively. The calorific value of this food was 382 kcal.

4.5 ENDURANCE TEST

4.5.1 Loading test

The endurance capacity of all the basket-ball players with sports food fed trial is presented in the Table 19 and depicted in Fig. 5. The mean calories burnt increased significantly from 63.35 kcal to 95.05 kcal (50.03%), after loading. The mean exercise time to fatigue also increased from 8.98 min to 13.35 min (51.68 %) after loading test. The mean distance covered during time to exhaustion was significantly higher (47.22%) after loading (19.87.50 meters) when compared to control trial (1350 meters).

Table 12. Mean values for anthropometric and biochemical parameters of the subjects

(N=32)

Anthropometry and haemoglobin parameters	Mean
Height (cm)	183.34
Weight (kg)	70.21
BMI	20.82
Waist circumference (cm)	79.60
Hip circumference (cm)	90.65
Waist-to-hip ratio	0.82
Mid upper arm circumference (cm)	27.90
Hemoglobin (g/100 ml)	13.88

Table 13. Distribution of subjects according to BMI (WHO, 2002)

(N=32)

BMI classes	Presumptive diagnosis	Frequency	Percentage
< 18.5	Under weight	6	18.75
18.5 – 22.9	Ideal BMI	21	65.62
> 23.0	Over weight	3	9.37
> 25.0	Obese grade I	2	6.25
> 30	Obese grade II	-	-

Table 14. Mean food adequacy of basket-ball players

(N=32)

Food groups (g)	SDA	Intake	% Adequacy
Cereals	550	438.83	79.78
Pulses	40	79.09	197.72
Green leafy vegetables	150	10.85	7.23
Other vegetables	200	83.62	41.81
Roots and tubers	150	101.54	67.69
Fruits	150	135.58	90.38
Milk	750	566.54	75.50
Fats and oils	50	90	180
Nuts and oil seeds	NA	46.93	-
Sugars	80	95.70	119.62
Egg	100	98.75	98.75
Animal foods	250	182.22	72.80

* SDA (Suggested Dietary Allowance) Source: Satyanarayana *et al.* (1985)

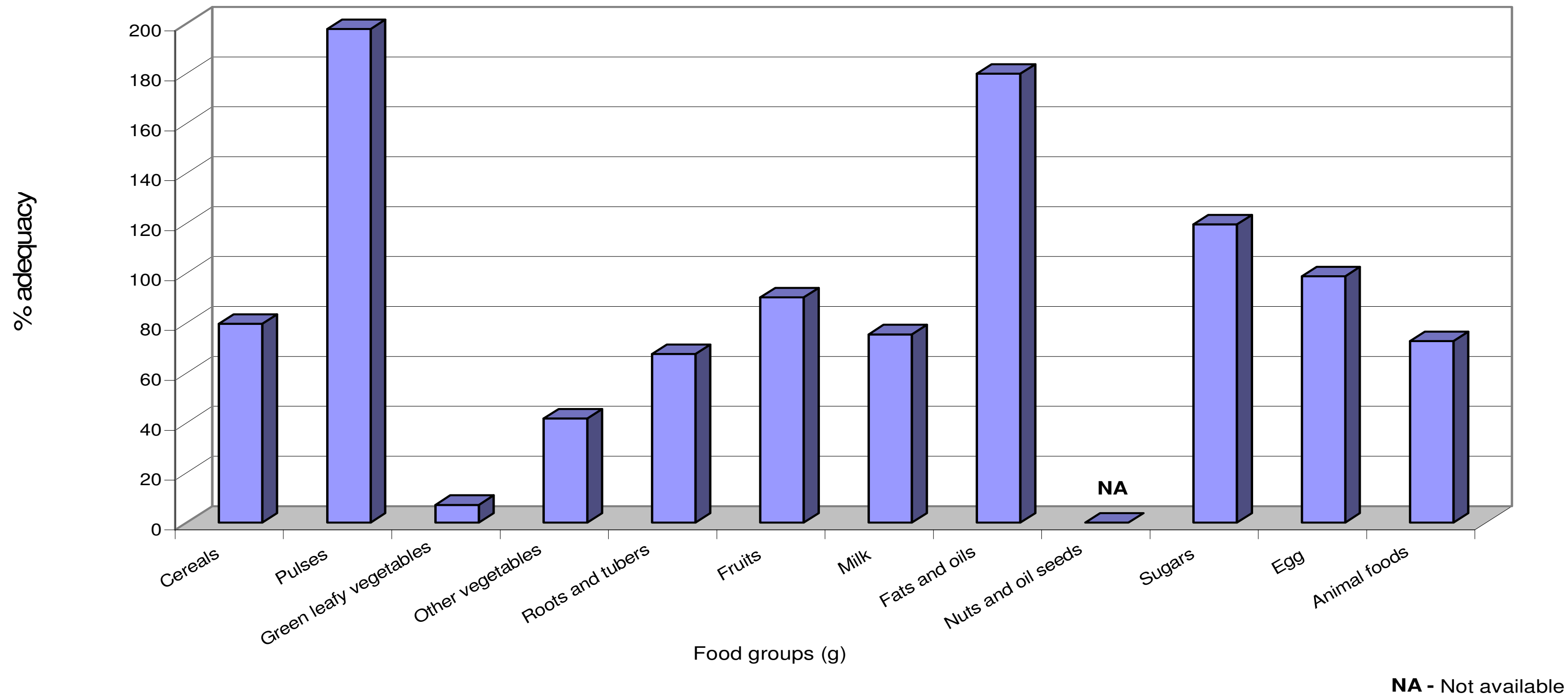


Fig. 3. Mean food adequacy of basket-ball players

Fig. 3. Mean food adequacy of basket-ball players

Table 15. Mean percent adequacy of nutrients by subjects

(N=32)

Nutrients	RDA	Actual intake	% Adequacy
Energy (kcal/d)	4320	3546	82
Protein (g/d)	100-120	95	86.36
Fat (g/d)	NA	140.83	-
Carbohydrates (g/d)	250-1200	452.27	62.38
Retinol (µg/d)	900	747.12	83.01
Ascorbic acid (mg/d)	100-120	71.35	64.86
Follic acid (µg /d)		385.12	96.28
Thiamine (mg)	3-4	2.5	71.42
Riboflavin (mg)	3-4	2.3	65.71
Niacin (mg)	40-50	22.35	49.60
Zinc (mg/d)	11	10.1	91.81
Iron (mg/d)	50-75	26.11	41.77
Potassium (mg/d)	2000	1935.56	96.77
Calcium (mg/d)	1000	794.58	79.45

* RDA (Recommended Dietary Allowance) Source:(Gopalan and Vijayaraghavan, 1971)

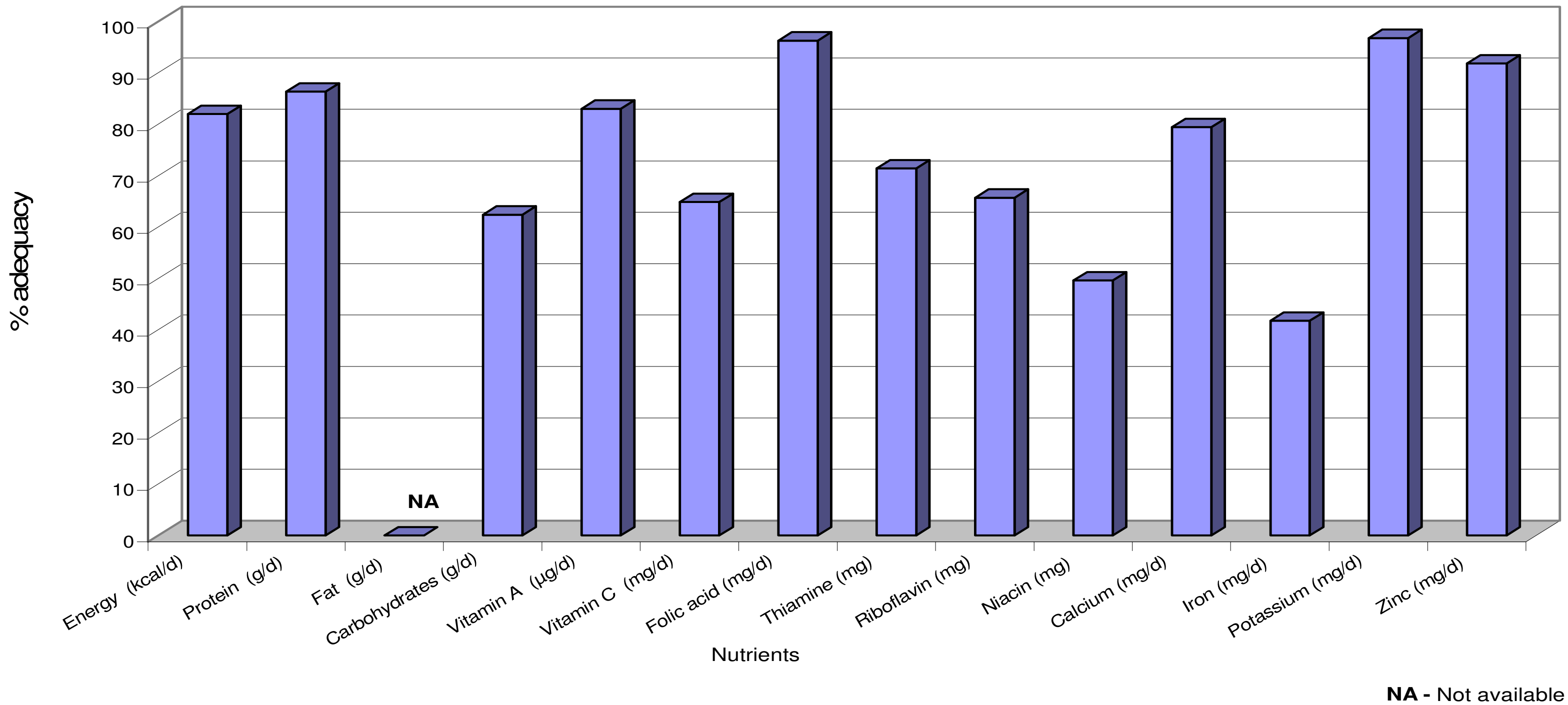


Fig. 4. Mean per cent adequacy of nutrient by subjects

Fig. 4. Mean per cent adequacy of nutrient by subjects

Table 16. Frequency of consumption of food

(N=32)

Particulars	Daily		Once in 2 days		Weekly twice		Weekly once		fortnightly		Once a month		Occasionally		Never	
	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P
Cereals	32	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulses	32	100	2	6.25	4	12.50	-	-	-	-	-	-	-	-	-	-
Oil seeds	11	34.37	-	-	11	34.37	7	21.87	-	-	-	-	-	-	-	-
Milk	32	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Curds/butter milk	12	37.50	3	9.37	9	28.12	3	9.37	3	9.37	-	-	1	3.12	1	3.12
Cheese	-	-	2	6.25	3	9.37	4	12.50	5	15.62	3	9.37	10	31.25	5	15.62
Egg	20	62.50	5	15.62	3	9.37	4	12.50		-	-	-	-	-	-	-
Chicken	4	12.50	13	40.62	4	12.5	4	12.50	4	12.50	-	-	3	9.37	-	-
Fish	-	-	-	-	6	18.75	10	31.25	5	15.62	6	18.75	5	15.62	1	3.12
Mutton	-	-	-	-	5	15.62	4	12.50	7	21.87	5	15.62	7	21.87	4	12.50
Green leafy vegetable	10	31.25	10	31.25	4	12.50	5	15.62	4	12.50	-	-	4	12.50	-	-
Other vegetables	5	15.62	10	31.25	10	31.25	5	15.62	2	6.25	-	-	-	-	-	-
Fruits	22	68.75	8	25.00	-	-	-	-	-	-	-	-	-	-	-	-
Butter	3	9.37	-	-	5	15.62	9	28.12	-	-	-	-	10	31.25	5	15.62
Ghee	-	-	10	31.25	-	-	3	9.37	3	9.37	5	15.62	10	31.25	1	3.12
Cooking oil	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sugar	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jaggery	4	12.50	2	6.25	6	18.75	7	21.87	3	9.37	4	12.50	6	18.75	-	-
Bakery products	3	9.37	-	-	12	37.5	6	18.75	3	9.37	-	-	8	25.00	-	-
Pizza	-	-	-	-	-	-	2	6.25	3	9.37	5	15.62	9	28.12	12	37.50
Burger	-	-	-	-	-	-	-	-	-	-	4	12.5	11	34.37	17	53.12
Noodles	-	-	-	-	-	-	3	9.37	5	15.62	7	21.87	17	53.12	-	-
Street foods *	-	-	-	-	2	6.25	8	25.00	10	31.25	7	21.87	4	12.50	-	-
Ice creams	-	-	20	62.50	3	9.37	4	12.5	3	9.37	2	6.25	-	-	-	-
Chocolates	3	9.37	7	21.37	7	21.87	6	18.75	4	12.5	5	15.62	-	-	-	-
Sweets	16	50.00	6	18.50	5	15.62	2	6.25	3	9.37	-	-	-	-	-	-
Soft drinks	4	12.50	17	53.12	2	6.25	2	6.25	2	6.25	2	6.25	3	9.37	-	-

* Street foods : Chats (Spicy, sweet and sour foods)

F – Frequency, P - Percentage

Table 17. Mean sensory profile of sports food

(N=100)

Particulars	Excellent (%)	Extremely good (%)	Very good (%)	Moderately good (%)	Good (%)	Fair (%)
Colour and appearance	29	29	22	6	10	4
Texture	26	20	24	15	10	5
Taste	52	21	15	10	2	-
Aroma	27	29	15	17	5	7
Over all acceptability	55	12	20	10	3	-

Table 18. Proximate composition of sports food (on dry weight basis)

Proximate composition (g/100g)	Mean value
Moisture	4.50 ± 0.10
Protein	12.65 ± 0.13
Fat	3.47 ± 0.17
Ash	2.84 ± 0.17
Crude fiber	1.5 ± 0.13
Total carbohydrate	75.04
Calorific value	382 kcal

Table 19. Endurance test on tread mill before and after loading

(N= 32)

Particulars	Control trial	After loading	't' value	% change
Calories burnt (kcal)	63.35 ±24.18	95.05 ±37.31	6.54**	50.03
Distance covered (m)	1350 ±475.86	1987.50 ±886.6	5.04**	47.22
Time of exhaustion (min)	13.35±4.79	20.25 ±8.98	4.13**	51.68

** - Significant at 1%

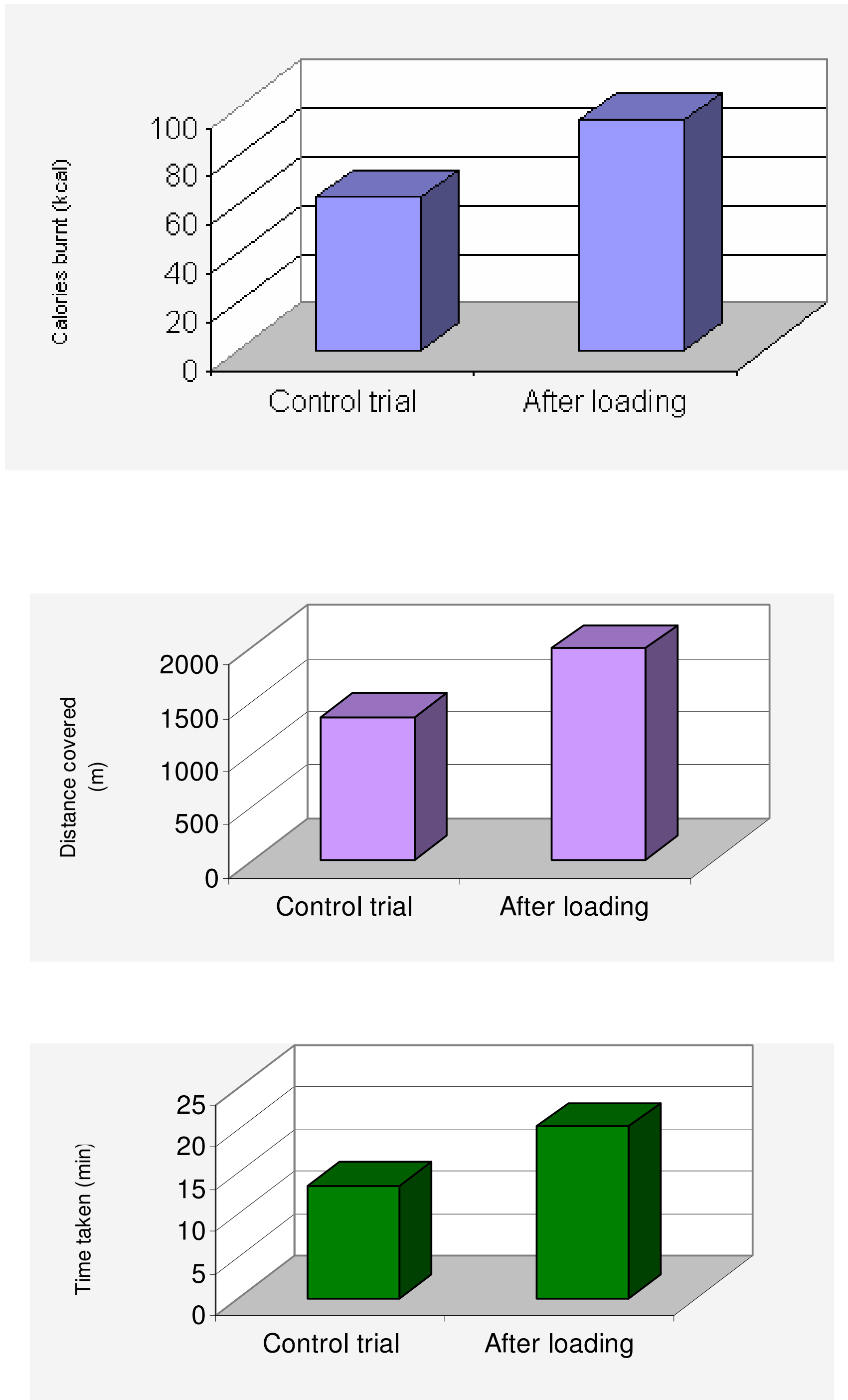


Fig. 5. Endurance test on tread mill before and after loading

Table 20. Anthropometric parameters before and after intervention

Anthropometric variables	Control (n=16)		't' test	% change	Experimental(n=16)		't' test	% change
	Initial	Final			Initial	Final		
Height (cm)	181.31±3.53	181.40± 3.49	1.37^NS	0.04	185.37±5.88	186.62 ±5.50	5.83**	0.67
Weight (kg)	69.87±8.57	69.93± 8.48	1.00^NS	0.08	70.56±11.99	71.81±11.50	4.03**	1.77
BMI	21.20±2.28	21.17±2.27	0.83^NS	-0.14	20.45± 2.97	20.54 ±2.88	0.82^NS	0.44
Waist circumference (cm)	76.57±9.09	77.82± 8.76	1.0^NS	1.63	82.62 ±8.67	83.96± 8.58	1.84^NS	1.62
Hip circumference (cm)	87.18±6.70	87.58 ±6.44	2.61*	0.45	94.12± 8.38	94.90 ± 8.02	2.24*	0.82
Waist to hip ratio	0.83 ±4.78	0.83 ±7.04	0.00^NS	00	0.81 ± 4.03	0.83 ± 6.19	1.86^NS	2.46
Mid upper arm circumference (cm)	27.68±16.75	27.73±16.84	1.09^NS	0.18	28.12 ± 3.36	28.18 ± 3.39	2.61*	0.21

** - Significant at 1% level
* - Significant at 5% level
NS - Non-significant

4.5.2 Supplementation test

4.5.2.1 Impact of sports food supplementation on mean anthropometric parameters of basket-ball players

The data on impact of sports food supplementation on anthropometric measurements is given in Table 20. Results revealed that mean height of experimental group increased significantly (P<0.01) from 185.37 cm to 186.62 cm (0.67%) after the intervention period where as, in control the mean height increased from 181.31 cm to 181.40 cm (0.04 %) group with no significant difference.

Mean weight of experimental group significantly (P<0.01) increased from 70.56 kg to 71.81 kg (1.77%), after the intervention period where as weight was increased from 69.87 kg to 69.93 kg (0.08%) in control group but significant difference was not there. The mean BMI in experimental group increased from 20.45 to 20.54 (0.44%) where as, in control group it decreased from 21.20 to 21.17 (-0.14%) respectively with no significant difference.

There was no significant difference was observed with regard to waist circumference after the supplementation period in both control and experimental group as mean initial values increased from 76.57 cm to 77.82cm (1.63%) in control group and from 82.62 cm to 83.96 cm (1.62%) in experimental group, while a significant (P<0.01) difference was found with regard to hip circumference in both the control and experimental groups after the intervention period, as mean initial values increased from 87.18 cm to 87.58 cm (0.45%) and from 94.12 cm to 94.90 cm (0.82%) in control and experimental group respectively.

The mean waist-to-hip ratio of control group was not differing significantly with regard to initial (0.83 and 0.83) and final values where as, it increased from 0.81 to 0.83 (2.46 %) in experimental group after intervention period, however significant difference was no not there. The mean initial value for mid upper arm circumference of control group was 27.68 cm which increased to 27.73 cm (0.18%) with no significant difference, where as a significant difference existed in experimental group as it increased from mean initial values of 28.12 cm to mean final values of 28.18 cm (0.21%) after the interention period.

4.5.2.2 Impact of sports food supplementation on haemoglobin levels (g/100 ml) of basket-ball players

Table 21 represents the changes in the mean blood haemoglobin level of the basket-ball players after the sports food supplementation (Fig. 6). The mean haemoglobin in values increased significantly (P<0.05) from 13 to 14.59 g/100 ml in experimental and 13.90 to 14 g/100 ml in control group with no significant difference.

4.5.2.3 Impact of intervention with sports food on endurance capacity of basket-ball players

The impact of intervention with sports food on endurance capacity of basket-ball players for the parameters like calories burnt, distance covered and time of exhaustion was presented in Table 22. Results revealed that calories burnt in the experimental group increased significantly (P<0.05) from 66.15 to 84.82 kcal (28.22%) after the intervention period, further the mean calories burnt also increased in control group from 60.56 kcal to 64.86 kcal (7.10%), however no significant difference was found.

Figure 7 clearly shows that, mean exercise time to fatigue after intervention period increased significantly (P<0.05) from 13.33 minutes to 18.29 minutes (37.20%) in experimental group whereas, it decreased from 13.37 to 11.6 minutes (-11.29%) in control group with no significant difference and the mean distance covered in experimental group increased significantly (P<0.01) from 1337.5 m to 1812.5 m (35.51%) whereas it decreased from 1362.5 m to 1356.25 m (-0.45%) in control with no significant difference.

Table 21. Impact of sports food supplementation on mean haemoglobin levels (g/100 ml)

Haemoglobin (g/100 ml)	Control (n=16)			Experimental (n=16)		
	Initial	Final	't' test	Initial	Final	't' test
	13.90±0.75	14 ±0.68	1.18[NS]	13 ±1.40	14.59 ±0.55	2.15*

* - Significant at 5% level
NS - Non-significant

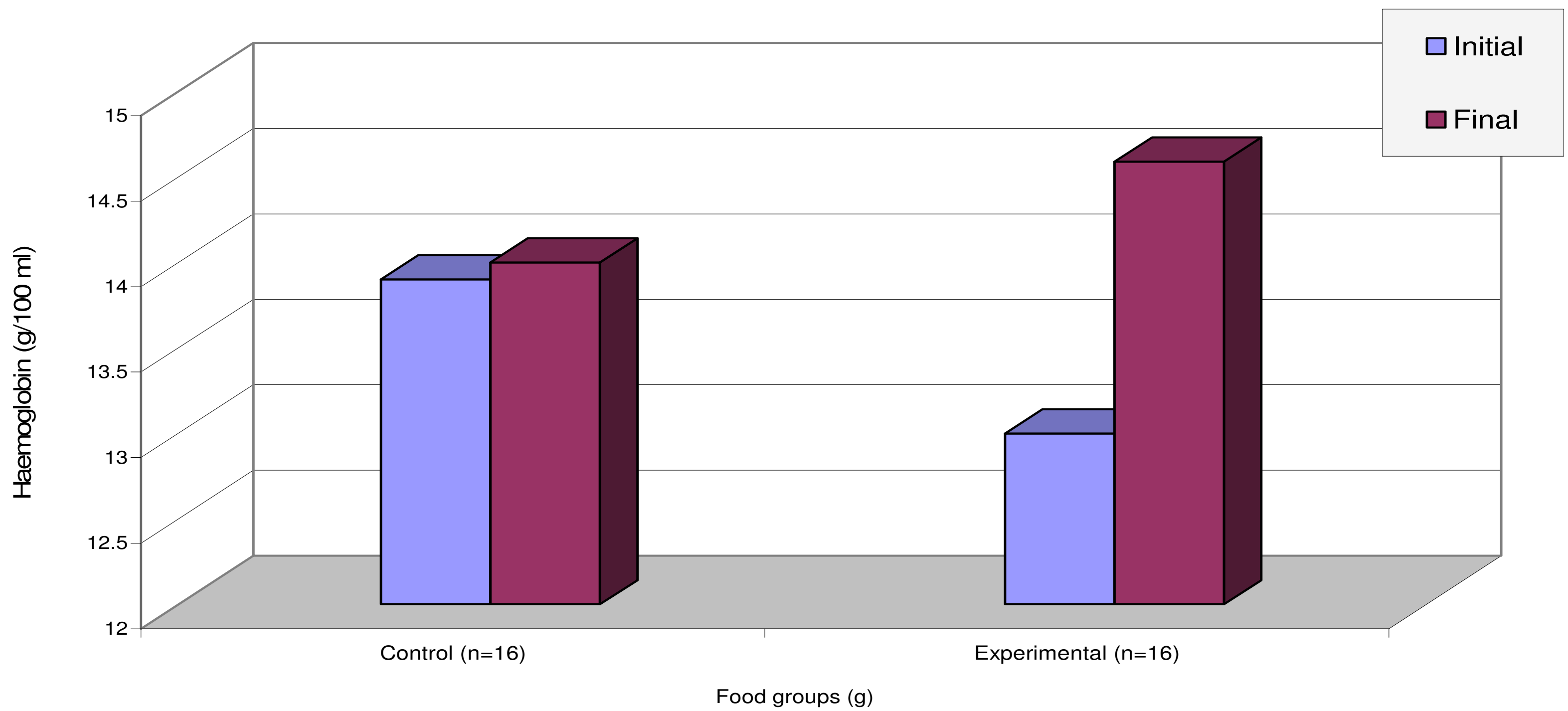


Fig. 6. Impact of sports food supplementation on mean haemoglobin levels (g/100 ml)

Fig. 6. Impact of sports food supplementation on mean haemoglobin levels (g/100 ml)

Table 22. Endurance test on tread mill before and after intervention

(N=32)

Particulars	Control (n=16)				Experimental (n=16)			
	Initial	Final	't' test	% change	Initial	Final	't' test	% change
Calories burnt (kcal)	60.56± 21.82	64.86±23.05	0.86 [NS]	7.10	66.15 ±26.75	84.82 ±30.89	2.60 *	28.22
Distance covered (m)	1362.5± 439.50	1356.25 ± 484.38	0.08 [NS]	-0.45	1337.5 ± 523.92	1812.5 ±610.87	5.87 **	35.51
Time of exhaustion (min)	13.37± 4.03	11.86 + 3.03	1.53 [NS]	-11.29	13.33± 5.58	18.29 ± 6.36	5.21**	37.20

** - Significant at 1% level
* - Significant at 5% level
NS -Non-significant

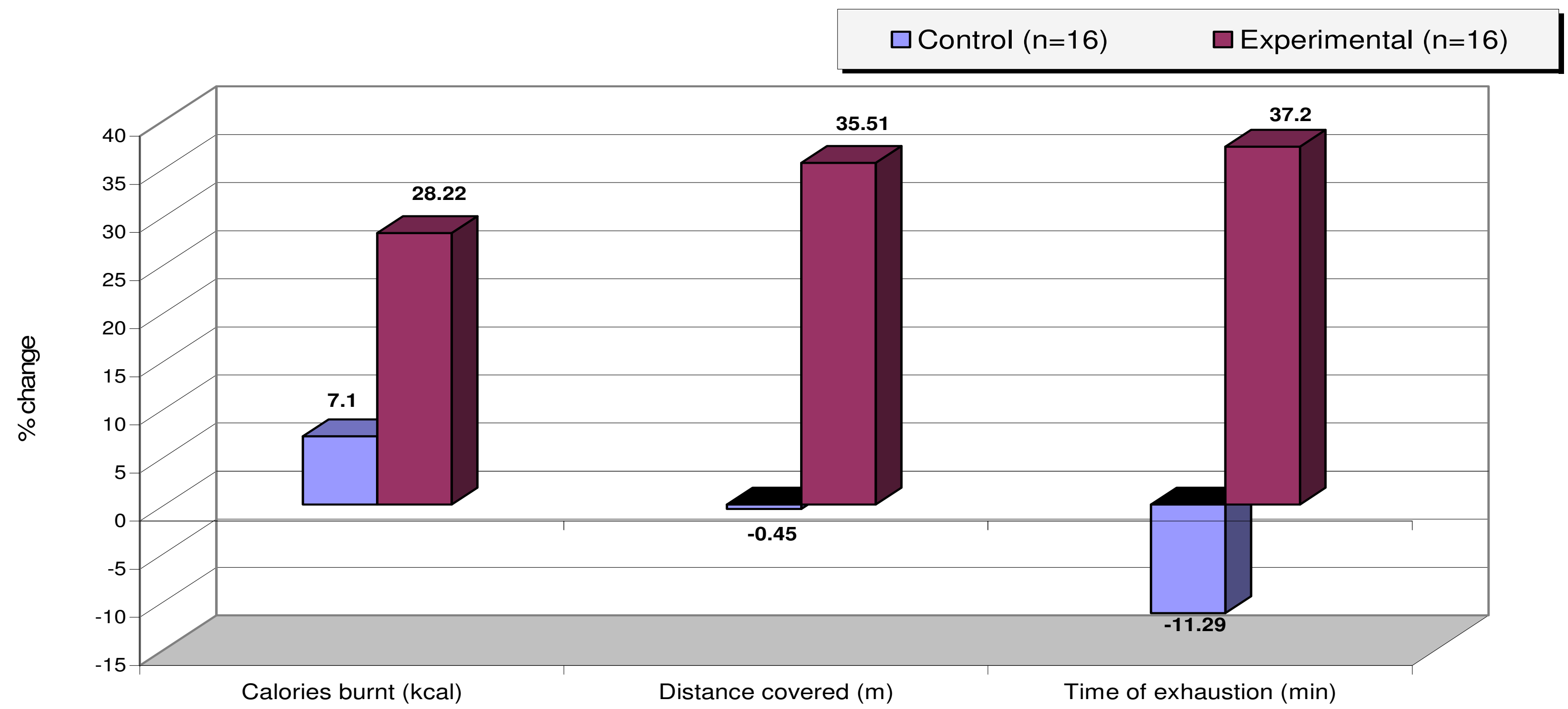


Fig. 7. Per cent change in the endurance capacity of basket players after the sports food supplementation

Fig. 7. Per cent change in the endurance capacity of basket players after the sports food supplementation

5. DISCUSSION

The results of the present study “Efficacy of sorghum based supplementary sports food on physical endurance of basket-ball players” are discussed here under this chapter.

India has a sound talent in all sports, it has talent of sporting regionally at young age, it also has good infrastructure facilities but still they are considered as 1 or 2 among 8 nations in Olympics. Where as countries like China, Japan, Australia and South Africa are leading nearly in most of the sports. The main reason for why India has not been able to do well is attributed to number of factors, major one is, Indians as a race happen to be physically of short stature, above all this, due to malnourishment and heredity problems they are unable to attain their potential levels, when compared with athletes of other nations. This has further been aggravated by poor nutritional status of Indian sportsmen.

Hence, there is a need to study the nutritional status of these sportsmen and to provide them with a nutrient rich sports supplement with proper guidance to use it, in order to enhance their endurance capacity and there by improving their sports performance.

5.1 NUTRITIONAL STATUS OF BASKET-BALL PLAYERS

The nutritional status of 32 trained, male basket-ball players was assessed for anthropometry; dietary intake and biochemical parameter were discussed as below.

Most of the basket-ball players in the present study were having tall, muscular, well balanced physique, however, the players had varying anthropometric variables depending on the genetic variation. The mean height and weight of basket-ball players were higher as compared to the ICMR standards on All India basis. Height is the most noticeable physical characteristic of basket-ball players and most of them were practicing basket-ball game 6 days a week (Table 3) and were practicing vertical jumping exercise daily (Table 5) which may be a contributing factor for tallness. Nudri *et al*. (1996) also observed that male and female athletes of basket-ball team were taller when compared with other groups of athletes. Most of the players had normal Body Mass Index (BMI) of 18.5 – 22.9 (Table 13), followed by under weight (<18.5) this may be due to the adolescent age group. Few of them were in over weight group (>23.0) and obese grade I group (>25.0). None were found to be in obese II group (>30). The waist and hip circumferences, waist to hip ratio and mid upper arm circumference were within the normal range, which may be because, the basket ball players need to develop strength and good body positioning to withstand contact in game and hence gaining lean body mass is crucial for basket-ball players. Fleck (1983) mentioned that among all sports, volley ball, basket-ball and rowing athletes have lean body mass higher than the athletes of other sports modality. The mean hemoglobin level of basket-ball players was 13.88 g/100ml (Table 12) which was considered as less because, the hemoglobin level of a sportsmen should be >14 g/100 ml (Nickerson *et al*, 1990).

Our Indian athletes face several barriers to achieve a good nutritional status mainly because of cereal based and vegetarian food habits when compared with non vegetarian food habits of other western countries. Other reasons may be increase in price of foods, tonic, sports supplements and medicines and also due to lack of nutrition knowledge, dietary extremism, poor practical skills in choosing or preparing meals, athlete are lagging behind in building sound nutritional status. Athletes with less than optimal nutritional status results in decreased endurance capacity and hence, compromise their physical performance. All the athletes in the present study were having non vegetarian food habits, but all were not consuming non vegetarian foods regularly (Table 16), there daily diet included mainly vegetarian foods. According to Nieman (1999), the vegetarian athletes with inadequate consumption of varieties of foods, suffer impaired nutrient status from the interactive effect of their heavy exertion and plant-food based dietary practices to the extent that performance, health, or both are impaired.

The inadequate consumption of food groups by the basket-ball players in the present study may be due to lack of awareness about RDA. About 50 per cent of the athletes stayed in the sports hostel and were not having choices for selection of foods and were consuming whatever food provided in the hostel mess. The players who were not residing in the hostel were consuming only a little extra varieties of foods which could not meet their adequacy and were consuming street foods, bakery products and soft drinks daily or every alternate days

(Table 16). Most of the players believed that milk, fruits and non vegetarian foods were proper food choices for increasing their strength rather than eating vegetables. Hence, the per cent adequacy for green leafy vegetables was less than 10 per cent and less than 50 per cent for other vegetables (Table 14). All the hostelites players and few non hostelites were in the habit of eating fruits, egg and sweets every day (Table 16). Hence, adequacy was more than 100 per cent for pulses, fruits, fats and oils, sugars and egg.

The sportsperson's diet should be high in carbohydrate, low in fat and moderate in protein (FAO/WHO, 1998). Around 60-70 per cent of total energy should be derived from carbohydrates, 25-30% from fat and 10-15 per cent from protein. Basket-ball players in the present study, had a marginal nutrient intake of energy (Table 15), as the diet provided 51 per cent of calories from carbohydrate, 10 per cent from protein and 35 per cent from fat, which adhere closely to the recommendations of Satyanarayana *et al*. (1985). The per cent of total energy from fat in case of basket-ball players was higher than the recommendations where as, carbohydrates and protein were lower than the recommendations, this may be due to excess consumption of fats and oils and also inadequate consumption of milk and animal foods by the players as observed in the Table 14.

The mean per cent adequacy for niacin and iron was less than 50 per cent while thiamine, riboflavin and calcium was less than 80 per cent when compared to the intake of folic acid, potassium and zinc which was more than 90 per cent. This may be because of low intake of green leafy vegetables and other vegetables (Table 14). More than 90 per cent adequacy for folic acid, potassium and zinc were may be due to regular consumption of foods like fruits, curds, cereals and pulses.

Moffatt (1984) also observed that female athletes had less than 75 per cent RDA for thiamine, niacin, iron and calcium. Low intake of iron by athletes was also reported by Tingler and Schiller (1989). Sohni and Singh (1997) observed inadequate nutrient intake of riboflavin (65.71%) and iron (41.77%) by sports women. Keith *et al.* (1989) also observed that cyclist diet was found to be low in energy (76% RDA), magnesium (81% RDA), iron (59% RDA) and zinc (48% RDA) while one-third of cyclist intake was below 67 per cent RDA for pyridoxine, folacin, cobalamine, vitamin-E, magnesium, iron and zinc.

5.2 DIETARY INFORMATION OF THE SUBJECTS

Special foods like milk, *badam* milk, soaked bengal gram, almond, cashew nuts, dates, raisins and banana were consumed by basket-ball players as special foods to improve their performance (Table 8). Almost all the players were consuming above mentioned special foods as per the prescription of their coaches and few of them were taking by self prescription and most of them were consuming these special foods after their morning work outs and few were consuming after evening work outs and after the dinner. The particular reasons given by them were, to gain energy, strength, stamina, power, to be fit and fine and to maintain good health. And few of the subjects were not taking any special foods as such to improve their sports performance and they prefer to eat regular foods only.

During the days of events i.e. before the start of the game, majority of the basket-ball players preferred to consume foods like *idli*, banana, sandwiches, fruit juices, biscuits, boiled potato and few of them did not prefer to consume any food (Table 9) and the particular reason given by them were *idli*, biscuits and sandwiches were light foods and they feel comfortable while playing and would not feel thirsty by consuming fruits juices while playing; further few of them preferred to consume boiled potato and banana as they feel energetic throughout the game may be because, these are rich sources of carbohydrates and helps in slow and sustained release of glucose through out the game. During events i.e. break times they preferred to consume glucose, fruit juices and electrolytes to combat dehydration, thirst and mineral loss due to sweat. Immediately after the event, most of them were consuming glucose, coconut water to cool down their body by rehydrating and few were consuming lassi, milk shakes and sweets especially chocolates for fast recovery and to feel relaxed as these foods contain both carbohydrates which aids in resynthesis of glycogen stores in the muscles and protein aids in attenuating muscle damages in the body. Some of the players were consuming fruit juices through out the game i.e. before, during and after the game to avoid dehydration problems. Glucose and electrolytes were consumed by most of the subjects during and after the game, to replenish their glucose and mineral loss.

Few days before the start of the events and on the event day, all the basket-ball players did not prefer to eat fried or oily foods (Table 10) as it has been prescribed by their coaches and the other reason given by most of them were to avoid heaviness, laziness and tiredness during playing, this may be due to increased fat deposition in the adipose tissue may result in heaviness in the body and results in nausea. Some of them avoided eating spicy foods and junk foods as it may upset their stomach due to impaired digestion. Milk and egg were also avoided by few players as they believed that, it may make their body hot and they may feel uncomfortable while playing. All the basket-ball players avoided eating heavy meals and rice few hours before the start of events and reasons given by them were, to avoid vomiting sensation, heaviness and also to avoid sleepiness during playing.

During break times some of the athletes avoided consuming soft drinks (carbonated beverages) and ice water as it may affect their health. At the end of the event day, some of the athletes mentioned that they did not take heavy meals, fried foods and spicy foods, as it causes lot of discomfort in their stomach due to fatigue.

5.3 WATER CONSUMPTION AND EXERCISING HABIT OF BASKET-BALL PLAYERS

Sport participants have high fluid requirements, as fluid loss is particularly high due to sweating. Sport activities involve a high expenditure of energy in the form of heat. Excessive increases in body temperature are prevented by sweating. About one liter of fluid per hour on average can be lost through this cooling system, and the loss must be replaced. Even small losses of fluids (1%-2% of body mass) lessen athletic performance.

In the present study, majority of the basket-ball players were in the habit of drinking 100-150 ml (Table 11) and few were drinking 50-100 ml of water 15 minutes before the event but, it is generally recommended to drink about 400- 600 ml 2 hours before and 150-350 ml 15 minutes before the start of exercise or event (Convertino *et al*., 1996). During the event or exercise i.e. time outs, quarter or half-time breaks, and time spent on the bench, some of the players were in the habit of drinking 150-200 ml and 100-150 ml of water. Further, few of them were drinking 200-250 ml of water but general recommendation is to drink small and frequent amounts i.e. 150 ml for every 15-20 minutes and it is also suggested to drink 100 ml every 10 minutes which would provide 600 ml for events which lasts for an hour and would go some way to limiting the effects of dehydration (Dennis *et al.,* 1997). Most of the basket-ball players were drinking 1 liter and few were drinking 500 ml of water immediately after the event or exercise where as, some of the players continue drinking about 1000 ml of water for few hours also. It has been suggested that after the exercise or event 500 ml of water should be consumed immediately and continue drinking for about few hours later also. In the present study water drinking habits of basket-ball players during event times is less than the recommendation levels, this loss of fluid may result in shortness of breath, dizziness, circulatory disorders, vomiting, and muscle cramping.

Explosiveness and repeated short bursts of exercises are important components of basketball game. Stepping exercise was performed by all the basket-ball players and deeps were performed by around 94 per cent of the players (Table 5) which are performed to build explosive power in the legs and arm muscles (Isaacs 1998 and Stapff, 1998). Sprint which was practiced by all the players and it is more a basketball specific and functional exercise as noted by Bridle (1999). Muscular strength is also regularly assessed due to it's importance within a game as basketball game requires numerous skills which must be applied dynamically, explosively and repeatedly. Hence, muscular strength of the arms and legs both are important to be considered (Bridle 1999 and Stapff, 1998). In the present study 46.87 per cent of the basket-ball players were practicing bench press and shoulder press including knee extension exercises to build muscular strength.

The jump is an explosive motor task used commonly throughout the game of basketball in different forms. The jumping exercise is used to build anaerobic power of the legs (Stone and Steingard, 1993). The vertical jump was another simple exercise practiced by all the basket-ball players, which is very specific to the requirements of basketball game which require jumping in all aspects of the game. The main skills involved in jumping are the lay-up, jump shot, rebound, shot block and intercepting ball passing which are specific lower limb strengthening exercises (Mc Ardle *et al*. 1996).

5.4 CHARACTERIZATION AND SENSORY PROFILE OF VALUE ADDED SPORTS FOOD

Sports food was characterized at laboratory level for parameters like colour and appearance, texture, taste and aroma. Judges have evaluated colour and appearance as very attractive, creamish, appealing, pleasing, good, uniform pleasant cream colour; for the parameter texture, judges have characterized it as fine powder, smooth, amorphous. Taste was characterized as very tasty, delicious, balanced sweet taste. Further, aroma was characterized as very pleasing and pleasant aroma, mild acceptable flavor, and mild malted flavor. Sports food was highly acceptable when it was evaluated by 100 sports people from different sports categories, majority of the subjects have scored excellent and extremely good for color and appearance (Table 17) and others have scored it as very good, good, moderately good and fair and have given remarks to improve the appearance of the product as it looks like cereal flour and also suggested to add some attractive colors to improve its color and appearance. Further, for texture parameter, they have suggested to add some solid particles as it was very powdery. Majority of them had liked the taste of sports food as they have scored excellent for the taste and also suggested to add some more sugar to enhance its taste. For the parameter aroma, most of them have suggested to improve the aroma by adding different flavors as it has mild flavor of cereal flour. More than 50 per cent of the subjects have scored excellent for the over all acceptability of the product and few of them have scored it as very good, extremely good, moderately good and good but none of them have scored it as fair.

5.5 IMPACT OF SPORTS FOOD SUPPLEMENTATION

The results of the effect of sports food supplementation during short term study on endurance capacity and during long term study on anthropometric parameters, hemoglobin levels and on endurance capacity have been discussed here under.

5.5.1 Short term study

All the basket-ball players were loaded with 50 g of sports food which was having a calorific value of 191 kcal and was providing 37.46 g of carbohydrates 1.73 g of fat and 6.38 g of protein and tread mill running exercise was performed to assess the endurance capacity of all the basket-ball players through the parameters like calories burnt, distance covered and time of exhaustion (Table 19). The exercise time to fatigue during tread mill running with control and test food revealed that, sports food loading had improved the performance as the significant increase was observed in mean calorie burnt (50.03%), distance covered (47.22%) and time of exhaustion (51.69%) when compared with control trial. And there was an increment in endurance capacity after loading as observed in Table 23, individually.

The improvement in the endurance capacity in sports food loaded trial in comparison with the control trial may be due to carbohydrate availability and enhanced carbohydrate oxidation which is supported by Coyle *et al.* (1983), and Sherman *et al.* (1991) El-Sayed *et al.* (1997), who reported that carbohydrate feeding significantly enhances the performance in trained athletes when compared with placebo (control trial). And protein availability is also one of the important factor which has aided in the improved performance, supported by the similar results of Saundrera *et al* (2004) where, a carbohydrate beverage with additional protein calories produced significant improvements in time to fatigue and reductions in muscle damage in athletes and also reported that, presence of protein in the sports food may have stimulated glycogen synthesis activity. Loading of sports food 60 minutes prior to exercise might have resulted in slow rate of digestion and have decreased the insulin level and maintained the elevated glycogen levels for a longer time. Activation of glycogen synthetase by insulin may have increased the muscle glycogen levels which inturn improved the performance (Costill, 1981). The sports food used for present study has a low Glycemic Index (GI), as it is made up of whole grain sorghum flours and soy flour. Research has shown that relationship exists between GI and endurance performance. Anderson *et al.* (1994) reported that mean riding time to fatigue in cyclist after an oat meal trial (GI=77) was 13 per cent longer when compared to glucose trial (GI=100). Wee *et al.* (1998) provided high and low-GI carbohydrate meals for their subjects 3 hours before a treadmill run to exhaustion. There were marked differences in blood glucose and serum insulin concentrations during the 3 hours after eating.

Table 23. Impact of loading on endurance capacity of the basket-ball players

Sl. No.	Calories burnt (Kcal)		Distance covered (m)		Time of exhaustion (min)	
	Before	After	Before	After	Before	After
1	80.50	93.40	1800	2300	18.92	22.93
2	99.60	115.62	2000	2200	20.14	23.07
3	27.20	38.80	600	800	6.37	8.09
4	46.20	97.35	1000	2000	11.05	22.00
5	50.70	75.55	1300	1600	12.58	15.98
6	26.20	45.70	600	1000	6.34	10.28
7	98.60	110.62	1100	1000	10.59	10.11
8	63.80	115.40	1100	1700	11.02	16.99
9	49.80	92.30	1100	1700	11.30	17.08
10	46.90	142.60	900	3700	5058	38.09
11	94.80	115.70	2100	1800	21.50	18.42
12	86.70	130.80	1900	3400	20.28	34.40
13	113.70	125.10	2300	2600	22.59	26.90
14	70.30	63.00	1200	1400	11.58	14.26
15	55.80	63.28	1300	1400	12.57	14.91
16	47.70	49.10	1100	1100	11.00	11.04
17	28.90	61.90	700	1400	8.40	15.00
18	40.60	55.60	1000	1200	10.50	11.56
19	92.60	129.90	2000	2700	20.20	26.58
20	57.80	71.40	1200	1500	12.20	14.59
21	92.50	172.40	2100	3900	12.50	40.19
22	33.60	41.40	700	900	22.06	9.80
23	45.50	150.00	1100	3500	7.00	36.50
24	57.50	81.80	1300	1800	11.00	18.56
25	42.80	47.00	900	1000	12.48	10.33
26	45.90	63.00	1200	1400	9.40	15.30
27	65.90	137.80	1500	3100	12.30	30.58
28	60.80	115.50	1400	2000	15.32	20.20
29	50.70	65.10	1400	1500	13.59	15.20
30	95.30	140.00	1700	3000	14.40	29.58
31	88.20	140.40	2000	3000	17.08	29.58
32	70.40	94.40	1600	2000	15.57	20.20

Table 24. Impact of supplementation on endurance capacity of the basket-ball players

Sl. No.	Calories burnt (Kcal)				Distance covered (m)				Time of exhaustion (min)			
	Control		Experimental		Control		Experimental		Control		Experimental	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
1	28.90	48.90	80.50	85.40	700.00	600.00	1800.0	2000.00	8.40	10.58	18.92	19.58
2	40.60	58.60	99.60	101.00	1000.00	1000.00	2000.00	2000.00	10.50	9.59	20.14	20.42
3	92.60	89.80	27.20	41.08	2000.00	1900.00	600.00	900.00	20.20	17.49	6.37	8.56
4	57.80	58.20	46.20	90.30	1200.00	1100.00	1000.00	2000.00	12.20	12.00	11.05	22.18
5	92.50	90.80	50.70	70.48	2100.00	2000.00	1300.00	1600.00	12.50	11.08	12.58	16.00
6	33.60	32.80	26.20	56.22	700.00	700.00	600.00	1200.00	22.06	7.14	6.34	12.22
7	45.50	50.20	98.60	100.03	1100.00	1200.00	1100.00	1000.00	7.00	7.57	10.59	9.58
8	57.50	48.40	63.80	98.90	900.00	1100.00	1100.00	1600.00	11.00	11.00	11.02	15.58
9	42.80	41.08	49.80	95.50	1300.00	900.00	1100.00	1600.00	12.48	8.56	11.30	16.54
10	45.90	45.80	46.90	77.70	1200.00	1200.00	900.00	1800.00	9.40	10.35	5.58	17.58
11	65.90	60.80	94.80	133.90	1500.00	1400.00	2100.00	3000.00	12.30	14.30	21.50	31.00
12	60.80	74.80	86.70	96.24	1400.00	1400.00	1900.00	2500.00	15.32	13.59	20.28	24.59
13	50.70	121.50	113.70	130.63	1400.00	1500.00	2300.00	3000.00	13.59	11.00	22.59	30.25
14	95.30	89.30	70.30	110.40	1700.00	1700.00	1200.00	1700.00	14.40	15.00	11.58	17.40
15	88.20	70.48	55.80	60.08	2000.00	1600.00	1300.00	1400.00	17.08	16.00	12.57	14.18
16	70.40	70.45	47.70	89.30	1600.00	1700.00	1100.00	1700.00	15.57	14.57	11.00	17.00

The sports food used for the present study contains both carbohydrate and protein in right balance and new research from leading exercise science laboratory is now showing that sports supplement that contain protein in right balance with carbohydrate can delay fatigue even longer than a sports supplement that only has carbohydrate which is in accordance with the results of Koopman *et al.* (2004) and (Saunders, 2004). They reported that, supplementation of carbohydrate protein during exercise has been found to decrease the endogenous protein oxidation and increase the rate of protein balance and it also increases the availability of amino acid. And it helps by limiting the break down of muscle protein during prolonged exercise there by, attenuating muscle damage.

5.5.2 Long term study

There was significant increase in anthropometric parameters of the experimental group at the end of the intervention period of 30 days (Table 20). There was highly significant increase in the height (0.67%) and weight (1.77%) of the experimental group was observed when compare to control group. The mean BMI in both experimental and control group did not increase significantly. Though there was significant increase in height and weight of the subjects (Table 14), mean BMI was not significant. Since majority of the subjects were categorized as having normal BMI, some of them were categorized as under weight followed by over-weight and very few as obese grade-1; significant increase was not observed in mean BMI of the subjects.

There was significant increase in the hip circumference in both control (0.82%) and experimental group (0.45%). Where as, mid arm circumference (0.21%) of experimental group had increased significantly when compared to control group (0.18%). The reason for these increments may be because, majority of the basket-ball players were adolescents and the second highest peak growth velocity occurs during adolescence and there are dramatic changes in body composition. Other reason may be because, of the supplementation of sports food for 30 days might have contributed in their physical growth as, the mean daily macro nutrient intake of the subjects in the experimental group had increased, *i.e.* calorie intake increased from 3606 kcal to 3797 kcal and carbohydrate, protein and fat intakes had increased from, 435.43 g to 472.89 g, 95.71 g to 102.09 g, and 139.2 g to 140.93 g respectively.

Chromiak and Antonio (2002) reviewed that supplementation with amino acids (ornithine, lysine and arginine) every day before strength training increases muscle mass and strength to a greater extent than strength training alone. Further, Gibala (2002) indicated that acute effect of supplementation of protein eventually led to greater gains in muscle, following habitual training. Tipton *et al.* (2001) reported that acute ingestion of both whey protein and casein during 8 weeks of resistance training group results in muscle protein synthesis and increased arm circumference and cross-sectional area, but the increase was principally due to a greater increase in skin and subcutaneous fat.

The mean haemoglobin level raised significantly (12.23%) in the experimental group (Table 21) where as, it was not significantly raised in control group (0.71%) after the intervention period, this may be due to the presence of soy protein in the sports food which was supplemented for 30 days, this is also supported by Husaini *et al.* (1998), who demonstrated that young male and female elite badminton players were given a soy protein-based, nutrient rich beverage compared to a carbohydrate beverage to control group, had improved levels of VO2max and plasma iron status. Recent studies have shown a beneficial role for soy protein when used as supplement to improve plasma iron status, as soy flour contains 6mg of iron/100 gm of flour.

The endurance capacity increased significantly in experimental group when compared to control group (Table 22). In control group the calories burnt increased (7.10 %) after the intervention period but individual increment (Table 24) was not observed whereas, the distance covered (-0.45%) had decreased among few subjects (8 subjects). Time of exhaustion had also decreased among 11 subjects. However, the results were not differing significantly. Further, in the experimental group, distance covered (35.51%) and time of exhaustion (37.20%) had increased significantly ($P<0.05$) and calories burnt (28.22%) also had a significant increase ($P<0.01$) after the intervention period. The results are supported by the study of Renuka and Shanthi (2006) where, three days prior to match, experimental group was provided with CHO along with their daily diet. Physical performance improved significantly in experimental group *i.e.* rating for strength, agility and endurance were higher when compared with control group.

When the results of loading and supplementation were compared, loading test has shown good results with respect to endurance capacity (Table 20) as all the parameters like calories burnt, distance covered and time of exhaustion were relatively higher when compared to the results of intervention study. This may be because, loading with sports food 60 min before endurance test might have stimulated muscle glycogen synthesis during 1 hour before exercise and maintenance of glycogen in specific compartment of muscle fiber which in turn might have resulted in better performance. This was supported by the Coyle *et al.* (1985) who observed that pre-exercise carbohydrate feeding during an hour before exercise have the potential to increase liver and muscle glycogen concentration and also performance. The long term supplementation had resulted in gaining good muscle mass and haemoglobin level, and to a some extent endurance capacity as it has shown significantly good results with respect to anthropometric and bio chemical parameters (Table 21).

From the present study, it can be concluded that loading and supplementation of sports food has brought significantly positive results with respect to endurance capacity, anthropometry and haemoglobin levels of the selected basket-ball players. No side effects, discomforts or any other complaints were reported by all the athletes instead, all of them have highly appreciated the food after the endurance test, particularly after loading, they have reported that, they did not feel tired and their breathing (VO2max) had improved during exercising and they did not feel pain in their leg even though they exercised for more than 30 minutes continuously with the same speed. This may be due to adequate storage of muscle glycogen one hour prior to exercise and availability of increased amount of carbohydrate oxidation to exercising muscles and also presence of moderate amount of protein which has limited the endogenous muscle protein loss.

The sports food was highly nutritious and appreciated by, sports council of India, New Delhi. It was also highly accepted when it was evaluated by trained panel members at laboratory level. And it was also highly accepted when it was evaluated by 100 sports athletes of different categories and there was high demand for the food at the sports consumer level. The loading of sports food can be recommended for events lasting longer than one or two hours, as it has shown significant improvements in the endurance capacity of the basket-ball players. The sports food can also be recommended for the regular supplementation, as significant improvement had been noticed in anthropometric characters and haemoglobin level.

The study leads scope for the following future work :

1) To study the impact of supplementation of sports food on female athletes

2) To study the Impact of loading and supplementation on sports recovery

6. SUMMARY AND CONCLUSIONS

A study entitled “Efficacy of sorghum based supplementary sports food on physical endurance of basket-ball players” was undertaken during 2006-2007. The purpose of the present investigation was to assess the nutritional status of basket-ball players and to determine the effect of sports food on anthropometric, biochemical and endurance capacity of basket-ball players.

A total of 32 professional basket-ball players of Dharwad city were selected purposively for the study, of which 16 residential players were selected from a government institute, Sports Authority of India (SAI), and another 16 were selected from Rowers Basket ball club. General information such as age, education and occupation were collected through personal interview method by structured questionnaire. Information on sports activity, daily routine, food habits like type of diet, pattern of water consumption, number of meals or beverages consumed per day and special foods, foods taken and avoided for sports and frequency of consumption of different types of foods were collected.

Further anthropometric measurements were recorded and the biochemical parameters *viz*., hemoglobin level and endurance capacity was estimated at the baseline study. Out of 32 subjects, 16 were taken as experimental group and rest as control group. Sports food (50 g) in the form of porridge was given to the experimental group for a period of 30 days and no supplementation was given to the control group.

The demographic profile, dietary habits, exercise habits, sports activity were recorded by using a structured questionnaire. The anthropometric measurements, hemoglobin level and endurance capacity were estimated before and after the intervention period. The salient findings of the study are summarized below.

- All the 32 basket-ball players were males and belonged to different age groups. Majority of the players i.e., 56 per cent were between the age group of 18 and 21 years and only 28 per cent were between 16 and 18 years of age. Regarding literacy level of the subjects, maximum number of players (56%) were graduates whereas, 37 per cent were college students and only 6 per cent were high school students.
- Most of the basket-ball players were in the field of sports since 2-4 years, majority of the players had been playing basket-ball game for 2-4 years, and had played basket-ball at the district level followed by state and university levels, and most of them had acquired group championship.
- Most of the players were practicing basket-ball 6 days a week.
- Regarding practicing of exercises, all the players were practicing jumping, stepping and sprints, majority of them were practicing jogging, deeps and sit-ups and most of them were practicing bench-press, shoulders-press, knee-extension and bicep-curl since 1-2 years. On an average almost all of them were doing warm-up exercise since 2-3 years.
- Majority of them were spending 5-15 minutes for jumping exercises followed by 15-30 minutes for stepping and 30-60 minutes for jogging. Most of the exercises were practiced during the morning hours.
- All the players were non vegetarians, and were consuming 2 meals per day.
- Most of them were consuming 1-2 cups of tea as morning beverage, half of the subjects were consuming 1-2 glasses of juice per day.
- Most of them were consuming banana as special food followed by milk in the morning; *badam* and milk both in the morning and evening. Around 50 per cent of the respondents were consuming milk at night.
- Before the event, most of the basket-ball players were in the habit of consuming *idli* where as, majority of them were consuming glucose during the event and majority of them were consuming *lassi* after the event.
- Before the event majority of the athletes avoided spicy foods where as, most of the players avoided ice water during the event and heavy meals were avoided after the event.

- It was observed that majority of them consumed about 100-150 ml of water before event and most of them consumed 150-200 ml of water during the event, and majority of them consumed 1000 ml of water after the event.
- It was observed that around 66 per cent per cent of the basket-ball players were having ideal BMI , very few were under obese grade I group.
- The mean food adequacy of basket-ball players was higher w.r.t pulses (199 %), fats and oils (180%), sugar (120%), egg (98%) and fruits (90%) and the least food adequacy was observed for green leafy vegetables (7%).
- Mean per cent adequacy for nutrients was higher for protein (86%) in case of macro nutrients followed by folic acid (96%) in case of vitamins. Subsequently, among minerals it as higher for potassium (97%) and zinc (92%) and it was less than 50 per cent for iron (42%).
- All the basket-ball players were consuming cereals, pulses and milk daily, most of them were consuming ice creams soft drinks and chicken once in two days; most of them were consuming oil seeds bakery products and other vegetables twice a week. Most of them were consuming fish chats, jaggery and oil seeds once a week. Chats, meat, cheese, fish and noodles were the foods consumed by most of the subjects every forth nightly; noodles and chats were consumed once a month and occasionally by most of the players. Burger, butter, ghee, cheese were consumed occasionally by the players. Most of the basket-ball players never consumed burger.
- Regard to sensory profile of sports food most of the respondents rated excellent for over all acceptability and taste. Subsequently, very few of them rated as fair for aroma, texture, colour and appearance.
- Endurance capacity of all the subjects enhanced significantly in terms of calories burnt, distance covered and time of exhaustion after loading with sports food.
- Regarding height, weight, hip circumference and mid upper arm circumference there was a significant increase in experimental group when compared to control group. Whereas, no significant difference was observed in terms BMI, waist circumference and waist to hip ratio between the experimental and control group.
- After the intervention period, significant increase was observed in the haemoglobin level.
- Endurance capacity of all the subjects enhanced significantly in terms calories burnt, distance covered and time of exhaustion after the intervention with sports food.

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APPENDIX I

Questionnaire to elicit the basic information of a basket-ball player

Date:

I) General information

a) Name
b) Age
c) Education
d) Address Ph.No./Mobile:

2) Participation in sports activity

a) Since how long you have been a sports person ? ___________years
b) What are the other games you play ?

Name of the game	Number of times played per week
1	
2	
3	
4	
5	
6	

c) What is your level of participation in basket-ball ?
1. National level, 2. State level, 3. District level, 4. University level, 5. College level

d) Did your group get championship any time ? Yes/No
If yes, how many times ?

e) Did you get individual medal any time ? Yes/No
If yes, how many times ?

3) Information about daily routine

a) Do you exercise daily ? Yes/No
If yes,

Name of the exercise	Since when	Time spent (min)	Frequency per day
1			
2			
3			
4			
5			

b) Since how long you have been playing basket-ball ? _______ years

c) Do you practice your game every day ? Yes/No
If yes, how many times per week ?

d) How many hours do you sleep ?
Night_____ hrs Day ______ hrs

4) Information about routine food habit
a) Type of diet
Vegetarian/Non-vegetarian/Eggitarian

b) Which of these beverages do you drink in the morning ?
Tea/Coffee/Milk/any other
Number of cups per day ______

c) Generally how many meals you take per day ? ____
Do you miss any of these meals ? Yes/No
If yes how often you miss ___

5) Special food for sports

Type of food	Timing	Quantity	Reason	Who prescribed
1				
2				
3				
4				
5				
6				

a) Foods taken

Before event	Reasons	During event	Reasons	After event	Reason
1					
2					
3					
4					
5					

b) Foods avoided

Before event	Reasons	During event	Reasons	After event	Reason
1					
2					
3					
4					
5					

6) Water drinking habit

Quantity glass/ml	Before event	During event	After event

7) Frequency of consumption of food

Foods	Daily	Weekly twice	Weekly once	Fortnightly	Once a month	Occasionally	Never
Cereals							
Pulses							
Oil seeds							
Milk							
Curds/butter							
Cheese							
Egg							
Chicken							
Fish							
Mutton							
Green leafy vegetable							
Other vegetables							
Fruits							
Butter							
Ghee							
Cooking oil							
Sugar							
Jaggery							
Bakery products							
Pizza							
Burger							
Noodles							
Street foods *							
Ice creams							
Chocolates							
Sweets							
Soft drinks							

* Street foods : Chats (Spicy, sweet and sour foods)

8) Days menu followed in sports hostel

Days/ timing	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning 6:00-6:30	1 cup tea + Biscuits	1 cup tea + Biscuits	1 cup tea + Biscuits	1 cup tea + Biscuits	1 cup tea + Biscuits	1 cup tea + Biscuits	1 cup tea + Biscuits
Breakfast 8:30-9:30	*Poha* + Boiled egg (1) + Banana (2) + Milk 1 glass	*Upma* + *Sheera* + Boiled egg (1) + Banana (2) + Milk 1 glass	*Puri* + *Kurma* + Boiled egg (1) + Banana (2) + Milk 1 glass	*Paratha* + *Gravy* + Boiled egg (1) + Banana (2) + Milk 1 glass	Coloured rice + *Tomato gravy* + Boiled egg (1) + Banana (2) + Milk 1 glass	Egg omlet + Boiled egg (1) + Banana (2) + Milk 1 glass	*Idli/Dosa* + *Chutney* + Sambar + Banana (2) + Milk 1 glass
Lunch 12:00 – 2:30	*Chapathi* + 2 vegetable *Bhaji* + Lemon rice + Butter milk	*Chapathi* + Chicken curry + Rice + Sambar + Butter milk	*Chapathi* + 2 vegetable *Bhaji* + veg *palav* + Butter milk	*Chapathi* + Chicken curry + Rice + Sambar + Butter milk	*Chapathi* + 2 vegetable *Bhaji* + veg *palav* + Butter milk	*Chapathi* + Chicken curry + Rice + Sambar + Butter milk	Chicken/Muttan Biriyani + 1 sweet
Snacks 4:00 – 5:00	Tea + Biscuits	Tea + Biscuits	Tea + Biscuits	Tea + Biscuits	Tea + Biscuits	Tea + Biscuits	Tea + Biscuits
7:00 - 7:30	Seasonal fruit juice	Seasonal fruit juice	Seasonal fruit juice	Seasonal fruit juice	Seasonal fruit juice	Seasonal fruit juice	Seasonal fruit juice
Dinner 8:00 – 9:30	*Chapathi* + 2 vegetable *bhaji* + Rice + Sambar	*Chapathi* + 2 vegetable *bhaji* + Rice + Sambar	*Chapathi* + chicken curry + Rice + Sambar	*Chapathi* + 2 vegetable *bhaji* + Rice + Sambar	*Chapathi* + chicken curry + Rice + Sambar	*Chapathi* + 2 vegetable *bhaji* + Rice + Sambar	*Chapathi* + chicken curry + Rice + Sambar
Bed time	1 glass milk + 1 fruit	1 glass milk + 1 fruit + 1 cup Ice cream	1 glass milk + 1 fruit	1 glass milk + 1 fruit + 1 cup Ice cream	1 glass milk + 1 fruit	1 glass milk + 1 fruit + 1 cup Ice cream	1 glass milk + 1 fruit

APPENDIX II

Characterization of supplementary sports food

Name of the judge: Date:

Note: Please give your opinion in detail about each parameters mentioned below

1. Colour and appearance
2. Texture
3. Taste
4. Aroma

Signature of the judge

APPENDIX III

Scorecard for evaluation of value added products

Name of the products : Date:
Name of the judge :

1	Colour and appearance
	Excellent
	Extremely good
	Very good
	Moderately good
	Good
	Fair
	Very fair
	Poor
	Very poor
2	Texture/consistency
	Excellent
	Extremely good
	Very good
	Moderately good
	Good
	Fair
	Very fair
	Poor
	Very poor
3	Taste
	Excellent
	Extremely good
	Very good
	Moderately good
	Good
	Fair
	Very fair
	Poor
	Very poor
4	Aroma
	Excellent
	Extremely good
	Very good
	Moderately good
	Good
	Fair
	Very fair
	Poor
	Very poor
5	Overall acceptability
	Excellent
	Extremely good
	Very good
	Moderately good
	Good
	Fair
	Very fair
	Poor
	Very poor

EFFICACY OF SORGHUM BASED SUPPLEMENTARY SPORTS FOOD ON PHYSICAL ENDURANCE OF BASKET-BALL PLAYERS

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ABSTRACT

A study was conducted to assess the "efficacy of sorghum based supplementary sports food on physical endurance of basket-ball players" during 2006-07. The sports food which mainly included sorghum and soy flour, skimmed milk powder and sugar powder was given as a test food for loading and supplementation study.

A total of 32 professional basket-ball players of Dharwad city were selected purposively for the study. Anthropometric measurement and biochemical parameter *viz.,* hemoglobin level and endurance test on tread mill was estimated at the baseline study.

In loading test 50 g of sports food was given in the form of porridge one hour before tread mill test and endurance capacity was observed in terms of calorie burnt, distance covered and time of exhaustion. In supplementation study out of 32 subjects 16 were taken as experimental group and rest as control group. Experimental group was supplemented with sports food (50 g) for a period of 30 days. The anthropometric, biochemical parameters and endurance capacity were recorded in both control and experimental group before and after supplementation study.

The results revealed that the endurance capacity of all the subjects enhanced significantly in terms of calorie burnt, distance covered and time of exhaustion after loading test compared to supplementation test. Further, supplementation had shown an improvement in anthropometric characters and hemoglobin levels in the experimental group (12.23%) when compared to control group.