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## Chapter V

### Summary and Conclusion

Sports are necessary for human development, health (both physical and mental), championship, and a spirit of friendly competition. It has a positive impact on the personality of the individual. A sportsman is someone who can accept failure or loss without grumbling and who respects his opponents with fairness, kindness, and civility (John, 2009). Games and sports include all outdoor and indoor games and also athletics. sprints, middle-distance, and long-distance track events are the different types of events that are commonly held on the track. Sprinting may be defined as short distance running in a restricted time that needs more energy. Athletes around the world depend on nutrition for performance and endurance. Sports nutrition mainly focusses on athletes' athletic performance. Nutrition plays a critical role in keeping athletes healthy by reducing tiredness and disease caused by inadequate recovery and increase performance. A proper diet will aid athletes in reaching their ideal body size and composition, allowing them to achieve greater success in their sport. To sustain blood glucose throughout exercise, enhance exercise performance, and increase recovery time, athletes should consume enough food and hydration before, during, and after exercise.

Nutrient-dense bars are a common dietary supplement used by sprinters and others to meet their energy needs in daily life. It supplies the strength for sustained physical and mental activity. The present study attempts to develop a Nutraceutical energy-rich Nutribar that could benefit the women sprinters nutritionally and ergogenically which may increase their performance. Nutribar is an appropriate source of nutrition for sprinters. It is a type of nutritional food supplement that is made up of energy-rich ingredients that possess high nutritional content, total antioxidant, and nutraceutical potentials which serve as an energy booster.

#### Objectives and Scope of Research Work

The present study entitled **“Development and Evaluation of Nutraceutical Energy Rich Nutribar on the Sprint Performance of Women Athletes”**

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(a) Primary Objectives: To

- Develop instant energy food product incorporating Nutraceutical rich foods.
- Evaluate the acceptability, shelf life, nutrient and Nutraceutical potentials of the developed product.

(b) Secondary Objectives: To

- Collect the background details of the Athletes.
- Assess the Nutritional Status, Body Composition and Physical Performance of athletes.
- Assess the impact of supplementation of the developed Nutraceutical energy-rich food among under 20 years of age district-level women sprinters on sports performance.

Scope-

- To fulfill Sustainable Development Goals set in world assembly
- Empowerment of sportswomen
- Novel Food Supplement
- Body composition data for setting standards in sports policy

## Methodology

A ready to eat energy rich food product which is rich in nutraceutical, antioxidants and micronutrients and antioxidants was formulated from sweet potato, *Ulva fasciata* and basil seeds as main ingredient and standardized, organoleptically evaluated named 'Nutribar'. The complete composition and the process of preparation of Nutribar are not revealed since the product has been applied for patent (under examination) and published (202141013795A/28/03/2021), at Indian Patent Office, Chennai. The study was approved by the Institutional Human Ethical Committee of the Avinashilingam University (AUW/IHEC/FSN- 19-20/XPD-29) (Appendix I). The trial was also registered in the Clinical Trial Registry of India (CTRI) of ICMR and the trial registration number was obtained (CTRI/2021/08/035705). A total of 140 women district level sprinters with the age of 17-20 years from the Avinashilingam Institute for

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Home Science and Higher Education for Women, Coimbatore constituted participants of the study. Out of 140 sprinters 60 sprinters were selected for the supplementation study based on the inclusion and exclusion criteria.

From the selected 60 subjects, one sprinter was discontinued during the study due to covid 19, Hence, the experimental group constituted only 29 Sprinters during the supplementation. Socio economic status, clinical status, dietary survey (24-hour food recall) was assessed for all the sprinters, whereas nutritional anthropometry, biochemical parameters and physical fitness level were assessed on 60 sprinters before and 59 sprinters after the intervention. The Nutribar was supplemented to the 29 sprinters in the experimental group (for 90days) along with nutrition education, while the control group subjects were offered only Nutrition education without supplementation. The effect of supplementation was evaluated on selected sprinters. Nutrition education was given to all the 59 sprinters and their KAP was evaluated before and after the education.

**The salient findings of the study are as follows:**

- The developed product's sensory examination found that variant 2 of the formulated product received the highest score compared to the other two formulations and the standard. The mean scores obtained for colour by Variant V2 was maximum ( $8.08 \pm 0.81$ ) followed by V1 ( $7.88 \pm 0.72$ ), standard ( $7.48 \pm 1.12$ ) and V3 ( $7.04 \pm 1.05$ ). The higher the *U. fasciata*, the darker the formulations. The mean scores obtained for appearance by variant V2 was maximum ( $7.96 \pm 1.13$ ) followed by V1 ( $7.76 \pm 1.09$ ), Standard ( $7.32 \pm 1.37$ ) and V3 ( $6.88 \pm 1.480$ ). Similar trend was observed for texture, flavor and taste. It is observed that the mean overall acceptability of Variant V2 was  $7.68 \pm 1.55$ , Variant V1 was  $7.44 \pm 1.04$ , Variant V3 was  $6.48 \pm 1.47$  and standard was  $6.36 \pm 1.25$ . Variant V2 had higher mean overall acceptability score than V1, V3 and standard.
- Based on the results of sensory analysis, the mean score of second variation was higher than the mean score other developed product variations. Hence, second variation of Nutribar was chosen for the nutrient analysis with the standard.

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- The cost of the Nutribar as per the cost of the ingredients prevailing in Coimbatore city showed that 100 g Nutribar costed about Rs.30/-. Each Nutribar weighed 50g. Hence the cost of each Nutribar was Rs.15/-. The cost of Nutribar when compared with other commercial products revealed that the cost is minimal and affordable.
  - The developed Nutribar was found to be rich in macro and micronutrients. The energy content was found to be 441 Kcal. While its protein content was found to be 11.0g and fat content was found to be 15.5g. whereas the standard product contains 400.7 Kcal of energy; 10.2g of protein and 9.5 g of fat. The zinc and iron content of the developed Nutribar was 1.20 and 5.8mg/100g. whereas, the standard product consisted of 0.73 and 2.6mg/100g respectively.
  - The results of phytochemical screening showed the presence of secondary metabolites namely alkaloids, tannin and phenolic compounds, flavonoids, alkaloids, terpenoids, saponin and glycosides in the developed food product whereas glycosides were absent in the standard.
  - The standard Nutribar exhibited 3.2mg quercetin equivalent of flavonoids; 1.8 mg atropine equivalent of alkaloids; 0.7 mg linalool equivalent of terpenoids; 0.2 mg securidaside equivalent of glycosides; 0.6 mg tannic acid equivalent of tannin and 2.1 mg gallic acid equivalent of phenolic acid, which was found to be in high concentration in the Nutribar when compared to the standard.
  - The results on the Total antioxidant capacity revealed that the Nutribar was found to be high in TAC in terms of 158 µg/ gram equivalent of ascorbic acid when compared to the standard which contained 97 µg/ gram equivalent of ascorbic acid.
  - The study on shelf life at room temperature revealed that on the 0 - 7<sup>th</sup> day, the total bacterial count and total fungal count were below the detectable level for the developed Nutribar, whereas the total bacterial counts and total fungal count of the standard product were found to be above the detectable level on the 7<sup>th</sup> day. The shelf life of the Nutribar was found to be best within one week of preparation at room temperature.
  - The study on shelf life at refrigerator temperature at 4°C. revealed that fungus was

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not found from 0-7<sup>th</sup> days for the Nutribar, whereas the presence of fungus was seen in the standard product form 0-7<sup>th</sup> days of storage. On the 14<sup>th</sup> day and the 21<sup>st</sup> day, the total fungal count was found to be below the detectable level for the developed Nutribar. Whereas it was found to be above the detectable level for standard product. The total bacterial count for both standard product and developed product were found to be below the detectable level. The pH of standard Nutribars decreased from 5.0 to 4.0 for both standard and developed Nutribar within 28 days. The shelf life of the Nutribar was found to be best within three weeks of preparation at refrigerator temperature at 4°C.

- Among the 140 subjects, thirty one per cent of sprinters were in the age group of 17-18 years. Sixty nine per cent were in the age group of 19-20 years. of the 140 subjects, sixty nine per cent of the sprinters belonged to nuclear family and thirty one sprinters belonged to Joint family.
- Among the 140 sprinters, 20 per cent of the athletes belonged to low income group with the family income of Rs 33001 to 55000 per annum followed by 25.7 per cent in the lower middle class with Rs 55001 to 88800 per annum
- Parents' occupations showed that the majority of adolescent girls' fathers (22.9%) and mothers (19.3%) were labourers. About 15% of adolescent girls' fathers worked in the business world, while 21.8 per cent worked in the private sector. Mothers had jobs that were distinct from those of fathers. About 4.3 per cent of mothers worked in the private sector, while 37.2 per cent of mothers stayed at home. Government employees composed just 6.4 per cent of mothers and 6.4 percent of fathers.
- Baseline anthropometry data revealed that the mean height and weight and BMI of the selected subjects 17-18 years of age were recorded as 157.87cm, 55.35 kg and 22.12 kg/m<sup>2</sup> whereas the subjects 19-20 years of age were recorded as 157.39 cm, 54.99 kg and 22.11 kg/m<sup>2</sup> respectively. Both sprinters in the age group of 17-18 and 19-20 years were significantly shorter than their respective ICMR

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values (2020) standard counterparts. The BMI and weight of the selected athletes for both age groups were found to be slightly higher than the reference values. But prominent difference was not observed in the bodyweight of both the age groups when compared with (ICMR 2020). This finding showed that the selected sprinters were 'fit' in terms of bodyweight though shorter than ICMR counterparts

- The Body Mass Index was in the normal range among 45 per cent of the selected sprinters namely 18.5 to 22.9. Twenty one per cent of sprinters were underweight and had body mass of less than 18. Out of the 33.4 per cent of the athletes who had body mass index greater than 23, Twenty five per cent were in obese category.
- The mean triceps, biceps, subscapular, supra iliac, sprinters in the age group of 17-20 years was found to be  $9.45 \pm 1.10$ mm,  $7.66 \pm 1.41$  mm,  $12.52 \pm 1.91$ mm,  $13.01 \pm 1.42$  mm respectively
- The mean score of Waist hip ratio, body fat per cent, free fat mass, total body water, fat mass, skeletal muscle mass, lean body mass and BMR of the selected sprinters in the age group of 17-20 years were found to be  $0.81 \pm 0.03$ ,  $31.12 \pm 8.30$  kg,  $37.46 \pm 4.06$  kg,  $27.60 \pm 3.02$  kg,  $16.89 \pm 9.49$  kg,  $19.96 \pm 2.93$  kg,  $35.23 \pm 3.68$  kg,  $1184.30 \pm 87.58$  kcal respectively In the present study, it was found that the mean Body Fat percent of selected athletes were not in the recommended range. The rise in the fat mass among the sprinters might be due to the covid 19 lockdown. Studies have reported that the Covid 19 pandemic negatively affects athletes' body composition due to inactivity.
- Results on the biochemical parameters of the selected sprinters revealed that the mean hemoglobin (11.34 g/dl) was slightly lower than the referral range (12-15 g/dl). Blood glucose and serum Lactose Dehydrogenase (LDH) of selected sprinters were within the referral range.
- Clinical signs and symptoms of athletes were assessed by physician in terms of Dental caries, pale skin, pigmentation of nails, dizziness and giddiness, and poor appetite. Of the 140 sprinters, only 7 percent had dental caries. About 39.5 per cent of subjects had pale skin, and pigmentation of nails were observed in 40 % of

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sprinters, while 34 % per cent of subjects were reported to suffer from dizziness and giddiness. poor appetite was reported by 21.5 per cent of subjects.

- It was found that out of 140 families of 21.5 per cent of families reported diabetes,17 per cent hypertension, 11.5 per cent heart disease and 7.5 per cent asthma, 18 per cent obesity and 8 per cent cancer among their family members. 17 per cent of sprinter reported no disease prevalence in their families.
- Distribution of subjects according to ailment and morbidity status revealed that out of the 140 sprinters only 3.5 per cent, 4.5 per cent, 11 per cent and 3.5 per cent had jaundice, chest pain during exercise, fracture and asthma in the past respectively. none of sprinters reported allergy. No ailment in the past six months reported by 77.85 per cent of sprinters.
- Food habits of the subjects revealed that 73 per cent of the sprinters were Nonvegetarians whereas 27 per cent of the Sprinters were vegetarians. The meal pattern of the individual depends upon the family and the community to which they belong, 70 per cent of the subjects reported consuming three meals a day while 30 per cent of the subject consumed two meals a day.
- Among the sprinters, all the 140 (100 %) sprinters performed exercise for more than ½ hour. None of the sprinters were alcoholics or smokers. listening to music was adopted as a stress control method by sprinters, 18.57 per cent of sprinters read books to alleviate mental stress. while 54.28 per cent and 12.85 per cent play sports and yoga to control their mental stress respectively.
- The mean food intake of the sprinters was compared with the suggested food allowance of foodstuff by the International Life Science Institute, National Institute of Nutrition and Sports Authority of India (2007) for the specific event. Data on daily intake of different food groups showed that mean intake of cereal and millets (-14.5 %), pulses and legumes (g) ( -9.8 %), root and tubers (-79.22 %), fruits (-6.9 %), milk and milk products (-87.31 %) Meat (g) (-77.71 %), Fats and oil (-85.88 %), and Sugar (-98.1 %), were inadequate and found to be deficit which was reflected in their low nutritional profiles. This might be due to the impact of the Covid 19 lockdown.

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- It was found out that the mean energy, carbohydrate, protein and fat intake of sprinters in the age group of was found to be  $2400.85 \pm 285.58$  kcal,  $322.57 \pm 61.74$  g,  $45.80 \pm 15.01$  g,  $35.38 \pm 10.55$  g respectively. All the macro nutrient intake was deficit when compared to the Recommended Allowance ILSI, NIN and SAI (2007), energy intake was 23.72 per cent deficit, carbohydrate 25.91 per cent deficit, and protein 65 per cent deficit and fat 67.9 per cent deficits. Therefore, the nutrient intake was inconsistent.
  - The mean energy expenditure of women sprinters in the age group of 17-18 years was 2271.34 kcal /day with an excess energy expenditure of 14.54 per cent against the actual intake 1982.90 kcal /day. Similarly, the mean energy expenditure of Women sprinters in the age group of 19-20 years was 2266.99 kcal /day with an excess energy expenditure of 13.67 per cent against the actual intake of 1994.35 kcal /day. Both the age groups were at energy deficit levels. figure 16 depicts the mean energy deficit levels
  - Results on the Impact of supplementation on Anthropometric Measurements in the control group and experimental group after intervention revealed that the initial mean height was within the referral range of ICMR 2020 standard counterparts. There was an improvement in height of both the experimental and control group after the intervention, it was found to be significant. Weight and Body Mass Index of the experimental and control group (17-20 years) was slightly greater than the referral range given by ICMR 2020. The experimental group showed decline in weight and BMI after the supplementation, compared to the control and it was found to be significant at a 5 per cent level. Whereas, there was no significant improvement in weight and BMI of the control group.
  - The statistical analysis shows the initial waist-hip ratio of the control group and experimental group was slightly higher than the reference level, but after three months of intervention, the experimental group showed decline in WHR after supplementation of Nutribar. The initial value of fat percentage and fat mass of both the Experimental and Control group was higher than the reference value, the experimental group showed significant decrease in the fat percentage from 30.89 to 29.52 after supplementation. the fat mass value of experimental group and

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control group was not significantly decreased. There was significant increase in the BMR rate of the experimental group when compared to the control group. From the above results it was proved that supplementation of developed NutriBar will significantly improve Anthropometric parameters of selected sprinters. Hence Hypothesis 1 is rejected

- Results on the statistical analysis on the changes in biochemical parameters in the control group and experimental group after intervention revealed that the initial mean hemoglobin was slightly lower than the referral range. There was a significant increase in hemoglobin of both the Experimental and Control group after the intervention. Blood glucose and serum Lactose Dehydrogenase (LDH) of both the Experimental and Control group was within the referral range. The experimental group showed a significant decrease in LDH after the supplementation. From the above results it was proved that supplementation of developed NutriBar will significantly improve Biochemical parameters of selected sprinters. Hence Hypothesis 2 is rejected
- Statistical analysis on the impact on the Physical Performance in the control group and experimental group after intervention revealed that there was an improvement in the performance of both the groups such as 30m dash; 60m dash; sit-ups; Ruler drop test; Margaria Kalamen test, Agility test and standing long jump of both the Experimental and Control group after the intervention. There was no significant improvement found in the parameters; Margaria Kalamen test and Hexagon agility of the control group. From the above results it is evident that there is an improvement in the physical performance of the experimental group after supplementation of NutriBar. Hence hypothesis 3 is rejected.
- The statistical analysis revealed significant differences in the weight of the experimental group after supplementation, and it was found to be significantly decreased to the referral value at one per cent level. No significant difference was observed in the parameters such as height, body mass index between the Experimental and Control groups.
- The comparative data on the body composition parameters of both Experimental and Control groups after intervention was analysed with the help of independent t

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test which showed significant differences in the Waist hip ratio, fat %, Total body water and skeletal muscle mass of the experimental group after supplementation, and it was found to be significantly decreased to the referral value. Free fat mass, lean body mass, and BMR of the experimental group after supplementation of Nutribar were not significant.

- The comparative data on the Biochemical analysis of both Experimental and Control groups after intervention showed significant differences in the Hemoglobin, Blood Glucose and Serum Lactose dehydrogenase of the experimental group after supplementation, and it was found to be significant one per cent and five per cent level.
- Comparison of changes in Physical Performance between Control and Experiment Group revealed a significant difference in 30m acceleration test, 60m dash, Sit-ups, Ruler Drop Test, Margaria Kalamen test, standing long jump and Hexagon Agility test of the experimental group after supplementation, and it was found to be significantly improved to the referral range at one per cent level.
- The mean intake of nutrient was compared before and after intervention period for the control group and experimental group. The study found there was an increase in the energy intake of both group after intervention. The experimental group showed higher improvement than control group, but not meeting to the RDA for both the groups. The increment in the energy may be due to the supplementation of energy rich Nutribar for 3 months for the experimental groups.
- Data revealed that there was a significant positive correlation between the energy intake and blood glucose ( $r = 0.414$ ,  $P = 0.026$ ) which is found to be significant at five per cent level. The result also showed a positive correlation between Iron intake and haemoglobin ( $r = 0.453$ ,  $P = 0.014$ ) and calcium intake and haemoglobin ( $r = 0.454$ ,  $P = 0.013$ ) after supplementing of Nutribar for 90 days.
- The correlation between Body Composition and Physical Performance for Experimental group after supplementation with Nutribar was analysed with Pearson product-moment correlation coefficient. The result revealed that there was

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a significant positive correlation between 30-m sprint time and fat percentage ( $r = 0.504$ ,  $P = 0.005$ ) and fat mass ( $r = 0.472$ ,  $P = 0.010$ ).

- After nutrition education, the percentage of general nutritional knowledge from 42.3 % to 88.1 %, knowledge regarding food intake from 37.2% to 94.91 %, knowledge regarding sports nutrition from 47.45 to 98.30 % , Attitude from 40.67% to 89.83% and practice from 50.84 to 98.30 of all the women sprinters (17 -20 years) improved. The effect of nutrition education will improve Knowledge, Attitude and Practice after the intervention. Since the Hypothesis 4 is rejected
- Supplementation with the Nutribar had played a major role in the overall improvement of the anthropometric and biochemical profiles of the sprinters. The improvements in physical performance showed the efficacy of the interventions that were well documented among the subjects.

## **Conclusion**

From the above results, it is concluded that it was possible to develop energy-rich Nutribar and among the variations studied, the second variation had the highest percentage of acceptance and the developed Nutribar possessed high nutritional content, total antioxidant, and nutraceutical potentials. The developed Nutribar also was easy for consumption throughout the study period of training and post-competition for sprinters. practitioners involved in the training of recreational runners would be advised to consume the developed nutraceutical, anti-oxidant energy-rich developed Nutribar, Since the experiment group showed significant improvement in the performance after supplementation of Nutribar. Hence, developed Nutribar could be a healthier choice for complementing energy for Sprinters

## **Limitations**

- The sample size of sprinters is small
- Supplementation study could be done only in Institutional Volunteers due to Covid 19 pandemic

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- Since it was a strict Covid 19 lockdown, due to non-availability of food groups among the community, an imbalance in the food and Nutrient Intake was observed compared to post Covid period
  - Inadequate training and exercise of the Sprinters, closure of gyms and training places made the sprinters for chances of becoming overweight/obesity

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## Recommendations

- Transfer of technology of the published Nutribar to Industries to obtain patent.
- Commercialisation of the Nutribar and Popularisation among sports authority and sports personnel
- Long term studies on food supplementation with functional food could be attempted.
- Studies on the impact of Nutribar on other sports could be attempted
- Assessment of the nutritional status of other athletes in Coimbatore.
- Supplementation study could be conducted on athletes involved in other athletics and group events
- Provide follow-up nutritional education to both the athletes and coaches on dietary diversification/modification.
- All stakeholders involved in organized sport including athletes, parents, coaches and educators should be made aware of sport and development policy.