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SUMMARY AND CONCLUSION

The present research on, “Health status and impact of pregame sports supplements on the performance capabilities of sports persons and athletes” was conducted to assess the health status of athletes and develop an energy and protein rich low cost pregame supplement. The efficacy of the developed sports supplement was assessed on a group of selected athletes by evaluating performance capability tests before and after supplementation.

The research was carried out in Chennai city in Tamilnadu, India. As the study involved female athletes participating in sports and games, institutions which had well established sports and games departments were identified. Thus three colleges namely Queen Mary‘s college (QMC), Quaid-e-millath Government college for women (QMGCW) and Ethiraj college for women (ECW) were selected for the study.

Study sample for the present research included 530 female athletes in the age group of 18 to 24 years, who were young adults, in their prime productive stage. Complete enumeration was used in the selection of subjects. Socio-economic status and nutritional status were assessed for all the selected 530 athletes. From this 530 athletes, a subsample of 100 athletes were selected by judgment sampling method for evaluating the endurance capabilities and to test the efficacy of pregame sports supplements. In phase I, the socio-economic and athletic profile of the selected athletes were elicited through an interview schedule developed by the investigator. In phase II the nutritional status of all the 530 athletes was assessed by collecting data on anthropometric measurements, biochemical estimations, clinical examination and dietary pattern.

In Phase III performance capabilities of the subsample of 100 athletes were measured. The performance capabilities of the selected athletes namely health related physical fitness tests which included the cardio-respiratory tests in

terms of Harvard step test, tread mill test, 2000 m brisk walking, 1500 m middle distance running and flexibility tests in terms of modified sit and reach test, muscular endurance test in terms of push-ups were assessed. The skill related tests namely speed in terms 100 m dash and agility through shuttle run (4x10 m) were assessed.

In phase IV the development and standardization of pregame supplements were accomplished. Assessment of nutritional status and performance capabilities of selected athletes in Phase II and Phase III pointed out the need for enhancing the health status and endurance capacity of the athletes. Keeping cereals and pulses as the main ingredients several permutations and combinations were examined and final combinations of three types of nutrimix powders were developed. These variations had red rice (*Oryza sativa*), sago (*Manihot esculenta*), roasted Bengal gram dhal (*Cicer arietinum*), green gram dhal (*Phaseolus aures* Roxb*),* gingelly seed (*Sesamum indicum*), niger seeds (*Guizotia abyssinica*) and peanuts (*Arachis hypogaea*) as common ingredients. The type of millet was changed and three different variations were developed. Variation (V_1) had ragi (*Eleusine coracana*), variation II (V_2) had the millet jowar (Sorghum vulgare) and variation III (V_3) had bajra (*Pennisetum typhoideum*). All the ingredients were roasted till the acceptable aroma arose, cooled and powdered in the flour mill.

In order to assess the palatability and acceptability of the nutrimix powders developed a five point hedonic rating scale was used. The nutrimix powders were organoleptically evaluated by a panel of 25 judges. The nutrimix powder was evaluated for its appearance, colour, taste, mouth feel and flavor. Each criterion carried five scores and the products were evaluated for a total score of 25. Variation (V_1) which had ragi obtained maximum percentage score of 80. Hence this variation of nutrimix powder was chosen to develop the pregame supplements.

Variation1 (V_1) of the nutrimix powder which had scored high in acceptability tests was incorporated into several recipes and finally three recipe

were developed as pregame supplements. Nutridrink which was in liquid form, nutribar which had chewable consistency and nutriball which had a very soft mouth feel were selected for evaluation.

The composition, nutritive value and acceptability of these three supplements were evaluated following the same evaluation procedure. Nutridrink and nutribar had got high acceptability scores and nutriball had scored low. Hence nutridrink and nutribar were selected for supplementation and evaluation.

In Phase V administration and evaluation of the efficacy of the pregame supplements were undertaken. The two pregame sports supplements namely nutridrink and nutribar were selected for administration and evaluation. The efficacy of the selected supplements was assessed by studying the performance capabilities and health status of the selected athletes. For this purpose a sub sample of 100 athletes were divided into three groups. Group I with 33 subjects was supplemented with nutridrink. Group II with 33 subjects was supplemented with nutribar and Group III of 34 athletes did not receive any supplement and served as control group. The supplement was given to the athletes in the morning one hour before the start of the practice.

Prior to supplementation all the 100 athletes were gathered in one place and their initial height, weight, waist circumference, hip circumference, body fat and triceps skinfold thickness were measured by the investigator and blood haemoglobin and blood glucose values were estimated with the help of a clinical laboratory.

The performance capabilities of the sub sample of 100 athletes were studied initially. The health related and skill related physical fitness tests were carried out initially before starting the supplementation. The supplementation process continued for a period of 90 days. At the end of 90^{th} day when the supplementation was over, all the tests namely anthropometric measurements, performance capability tests, biochemical estimation and body composition were assessed again.

The salient findings of the research are presented below:

Phase I Collection of socio-economic and athletic profile of the selected athletes

1. The type of family of the selected athletes revealed domination of nuclear families (77%) with three to five members (63%).

2. The educational, occupational and income status of the parents were very low. Seventy two per cent of the selected athletes belonged to low income group with the family income of Rs 33001 to 55000 per annum.

3. The selected athletes were in the age group of 18 to 24 years. Maximum number of 189 athletes (36%) was in the age group of 18.

4. Most of the athletes were either first (38%) or second born (44%). Greater (88%) participation was noted in team events than track events.

5. Seventy four per cent of the selected athletes were super active since they had one hour of vigorous practice five days/week.

6. A maximum number namely 38 per cent participated at zone level and 16 per cent at district levels.

Phase II Health and nutritional status of the selected athletes

1. The mean weight of the selected athletes were less than the standard body weight recommended by ICMR (2010) for the 18 to 24 years age group for Indian female.

2. More than 50 per cent (53%) of the selected athletes were in the normal range of Body Mass Index namely 18.5 to 22.9. Mean waist to hip ratio was in the normal range of < 0.8 suggested for women by WHO (2008b).

3. Twenty five per cent of the athletes had more than 29.6 per cent body fat and thus were classified as very poor in high fat content. Forty four per cent were classified as fair and poor with a body fat percentage of 22.2 to 25 and 25.1 to 29.6 respectively.

4. The selected athletes had muscle mass greater than the standards prescribed by Omeran body fat composition analyser manual. The mean Basal Metabolic Rate recorded was higher than standard value given by ICMR (2010), indicating that these athletes had more muscular tissue. Muscular tissues require more energy and hence BMR was high for the selected athletes.

5. The mean skinfold measurement of the selected athletes was 11.78 mm which falls under adequate calorie reserve .

6. Fifty four per cent of the selected athletes had haemoglobin level more than 12 g/dl and hence were normal without anaemia. Twenty nine per cent were moderately anaemic and 17 per cent were mildly anaemic.

7. The fasting blood glucose values of the selected athletes were within the normal range of < = 126 mg/dl suggested by WHO (2009). None of the athletes had diabetes mellitus or other blood glucose related disorders.

8. Forty eight per cent of the selected athletes had no nutritional deficiency symptoms indicating good nutritional status.

9. The clinical examination revealed that 48 per cent of the selected athletes did not show nutritional deficiency symptoms. Poor musculature and pale conjunctiva were observed among 22 per cent of the selected athletes. Tenderness of the calf (25%), angular stomatitis (30%), and bleeding gums (30%) were registered indicating vitamin B complex and vitamin C deficiency. Dental caries was registered among 30 per cent of the athletes indicating poor calcium/vitamin D deficiency.

10. Dietary habits revealed that 78 per cent of the selected athletes were non-vegetarians or lacto-ova vegetarians. Normally three rice based meals per day was consumed by the athletes. Skipping of meals namely either breakfast or lunch was prevalent among 75 per cent of the athletes. Unhealthy food items such as parotta and other fast foods were selected by the athletes while eating away from home. Thirty four per cent of the athletes

were skipping their meals due to fasting. Sixty three per cent of the athletes had the habit of consuming deep fried snacks often.

11. Athletes preferred to consume light and energy rich foods before an event. Liquids such as glucose water, electrolytes, carbonated/malted beverages, lemon juice, tea or coffee were preferred by the athletes. Biscuits were preferred by 50 per cent of the selected athletes. Other solid foods such as banana, idli, bread and jam which do not contain fat were preferred by 32 to 40 per cent of the selected athletes. It is evident from these results that low fat, liquid and energy dense foods were preferred before starting an event. Since no special pregame supplements were available different food items were consumed by the athletes. These results point out the necessity to develop more pre game sports foods.

12. Electrolytes and glucose water were consumed during the break in the middle of the game. Liquids were consumed for the purpose of hydration. Twenty per cent of the subjects preferred consuming a small banana.

13. Heavy meals, spicy foods, fried foods and milk were avoided before starting an event. After an event, gradually the intake started with liquid foods and ended with solids. Forty per cent of athletes avoided chilled water or drinks during an event.

14. The water intake of the selected athletes before an event was 250 to 500 ml (86%). After an event 63 per cent of the athletes drank 250 to 500 ml of water. Only 45 per cent drank 750 ml to 1000 ml of water after an event. During the break nine per cent of them sipped 100 ml of chilled water to cool down their body temperature.

15. The mean food intake of the athletes showed that the consumption of cereals (93 %), pulses (70%), green leafy vegetables (73%), roots and tubers (67%) and sugar (75%) were nearer to the Suggested Dietary Allowances. But the intake of other vegetables (10%), fruits (20%), milk and its products (20%),

egg (50%) and animal foods (20%) were deficient in the diet of the selected athletes. Consumption of nuts and oil seeds and fats and oils were found to be higher than the suggested dietary allowances given by Sathyanarayana et al., (1985). It was noticed that processed snacks were popular than homemade snacks.

16. Mean nutrient intake revealed that their intake of energy was only 58 per cent of the Recommended Dietary Allowances suggested by Sports Authority of India. The protein intake was very low (33%).

17. Health profile revealed that with regard to the various dimensions of wellness more number of athletes (80%) had expressed that they were emotionally happy. Sixty eight per cent had expressed positive attitude about their involvement in sports and games, while 44 per cent had negative feelings. The negative feelings were mainly during the defeat, or if they did not get prize/trophies for their performance.

18. The ailments confronted most commonly by the athletes included leg pain (50%), menstrual problems (29%), pelvic pain (13%) and pain in muscles and joints (10%).

19. Symptoms of over training syndrome were noted among the athletes. Twenty per cent of the selected athletes reported that they experienced sudden drop in their performance during stressful events. Fifteen per cent reported pain in muscles and joints during strenuous exercise and games. Menstrual problems in terms of irregular periods, amenorrhea and premenstrual syndrome were experienced by 14 per cent of the athletes. Menstrual irregularities were reported to be due to heavy exercise and practice. Headache and fatigue were felt by 10 per cent of athletes in each group.

Phase III Performance capabilities of athletes

1. Forty one per cent of the subjects had secured scores above 90 and thus they were classified under excellent category in the physical efficiency index. Thirty eight per cent of athletes had scored between 80 to 89 moving out of the high

fitness zone to a low performance zone. Twenty one per cent of the selected athletes were in the high average zone indicating reduction in performance capability.

2. In treadmill test a maximum distance of 1.58 km /12 minutes and a minimum distance of 1.32 km /12 minutes were recorded by the selected athletes.

3. The distance covered in electronic bicycling test revealed that 21 per cent of the selected athletes covered the distance of 2.26 km to 2.68 km in 15 minutes.

4. In 2000 m brisk walking 15 per cent of the selected athletes had completed with the very good pace to cover the distance in 12.0 to 13.59 seconds. Thirty per cent covered the distance with slightly lesser speed to complete the distance in 14.0 to 15.59 minutes. Thirty two per cent had taken 16.0 to 16.59 minutes to complete the 2000 meters brisk walking.

5. Seventy eight per cent of athletes had taken 6.0 to 6.9 minutes to complete the 1500 m middle distance running followed by11 per cent each completing in 5.0 to 5.9 and 7.0 to 8.9 minutes.

6. The time taken in seconds to complete the 100 m dash ranged from 14 to 22 seconds. The results indicated that 42 per cent were in the excellent category with highest speed. At the same time 18 per cent were classified as fair and the speed was very low.

7. The time taken to complete the shuttle run indicated that 87 per cent were able to cover the distance within 10 to 12 seconds. Three per cent had covered in 12 to 14 seconds. The rest 10 per cent took 14 to 16 seconds to cover the distance.

Phase IV Salient features of the pregame supplement formulated

1. The three variations of the nutrimix powder contained 65 g of carbohydrates and 440 kcals. The protein, fat and iron contents were equal in all the three combinations while calcium was much higher in nutrimix V_1. The cost of V_1

and V_3 were the same namely Rs 8.77 while the cost of V_2 was slightly lower. The excess calcium level in V_1 variation was due to the presence of ragi. It had 344 mg of calcium per 100 g. The cost of nutrimix V_2 was low because of the low cost of Jowar. But for these two factors all the other components were equal in the three variations.

2. The results of the microbial analysis of the nutrimix powder conducted in the fresh sample and sample stored for three months, point out that there were no bacterial contamination in the fresh sample. Yeast and mould counts were below the detectable level. After a storage period of three months, yeast and mould counts were below detectable level and bacterial count was 3000 (cfu/g) which was within the safe limit which does not cause deleterious impact on health.

3. The pregame supplements had nutrimix powder (30g), jaggery (20g) and glucose (10g) which were the common ingredients added to all the three recipes. For nutridrink milk (40g) was added to get fluid consistency. For nutribar, banana (30g), ground nuts (5g) and niger seeds (5g) were added. In nutriballs sago powder (25g), niger seeds (5g) and ghee (10g) were added. The total weight of ingredients in each recipe was equal to 100 g. To bring the nutridrink to fluid consistency 150 ml water was added.

4. With respect to the acceptability of the pregame supplements, a maximum score of 20 was obtained by Nutridrink followed by Nutribar. Hence these two were chosen for supplementation. Nutridrink was preferred due to its good flavour, colour and acceptable mouth feel. Nutribar had attractive brown colour with appetizing banana flavour, soft mouth feel but took little more time to chew due to the content of nuts. Nutriballs scored less because of its sticky consistency and the flavour which was not acceptable.

   Due to high acceptability scores nutridrink and nutribar were chosen for supplementation to the selected athletes early in the morning one hour before practice.

Phase V Efficacy of the pregame nutrition supplements developed

1. Health related physical fitness test namely cardio-respiratory endurance showed increased physical efficiency index. The distance covered by the selected athletes in the treadmill test had increased from 1.44 km to 1.69 km after supplementation. Values registered in electronic bicycling, 2000 meters brisk walking and 1500 meters middle distance running showed improvements which were statistically significant at one per cent level ($p<0.01$) for nutridrink group. With regard to nutridrink group the ability of the selected athletes to perform the Harvard step test had increased after supplementation which was statistically significant at one per cent level ($p<0.01$).

2. The values registered by the nutribar group for the cardiorespiratory endurance tests had recorded improvements after supplementation. The increase in the values were significant at five per cent level ($p<0.05$). But contrary to these values the control group did not show improvements after a period of three months. The difference in the values were also not significant.

3. Under health related physical fitness test muscular endurance measured through push-ups and flexibility studied by modified sit and reach test had also shown improvements, which were statistically significant at one per cent level ($p<0.01$) for nutridrink group. The nutribar group had registered improvement at five per cent significance level. The control group did not register any statistically significant improvement.

4. With respect to skill related physical fitness the time taken to cover a distance of 100 meters had significantly decreased for the nutridrink and nutribar groups after supplementation. The decrease in time taken was statistically significant at one per cent level ($p<0.01$) for the nutridrink group and at five per cent level ($p<0.05$) for nutribar group after supplementation. Control group did not show improvement and hence the difference was also not significant.

5. The haemoglobin values increased from 11.36 g/dl to 11.44 g/dl for nutridrink group while the nutribar group had shown an improvement of 0.02 g/dl after

supplementation. The increase in haemoglobin values were statistically significant at one per cent level ($p<0.01$) for nutridrink group after supplementation. For the group which consumed nutribar the supplement had brought an increase in haemoglobin which was statistically significant at five per cent level ($p< 0.05$). Control group did not show statistically significant improvement even after a period of three months.

6. Regarding the height, there was no difference in the mean height of all the three groups after the period of supplementation. But in the case of nutridrink group there was a slight increase in the mean body weight. There was no change in mean height and only weight had increased. The mean body mass index registered a higher value of 21.83 compared to the initial body mass index value of 20.89. But the difference was not statistically significant. For nutribar group and control group no significant changes were noticed in height, weight and Body Mass Index. Same trend was observed in waist circumference and waist to hip ratio also. No statistically significant difference was noticed among the groups studied. The results of anthropometric measurements showed a slight increase in body weight and not in BMI of subjects in the nutridrink group and no other significant change was noticed in other measurements for nutridrink group.

7. For the group supplemented with nutribar a marginal increase in triceps skinfold fold measurement and body fat per cent were recorded. But here also the difference in the values were not statistically significant. In the case of control group neither the mean values nor the statistical analysis showed any significant change.

The basic principle of sports excellence is mainly dependent on athletes' physique and dietary intake apart from training and physiological concepts. Milk protein which was added in nutridrink had the advantage of both casein and whey proteins. Ragi supplied extra calcium needed for bones to achieve maximum mineralization. In addition to providing energy, calcium and iron nutridrink increased physical fitness and mental alertness.

From the foregoing results it is evident that the nutridrink which was developed by a judicious combination of locally available low cost nutritious foods was more efficient in enhancing the endurance capacity, haemoglobin levels and body weight of the selected athletes. Hence, a continuous and regular intake of nutridrink will be efficient in optimising the athletic performance. Supplementation of nutridrink as pregame intervention for athletes would enhance the performance in the sports and games. This would in the long run benefit the individuals and bring laurels to the country in national and international level games.