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Effect of supplementation of malted ragi (*Eleusine coracana*) beverage on nutritional status of sportswomen

Megha Bansal and Navjot Kaur

Ragi, the low cost millet, is a rich source of dietary fibre, calcium and phytochemicals with nutraceutical potential. Ragi contains about 6-13 per cent protein, 1-2 per cent fat, 65-75 per cent carbohydrates, 15-20 per cent dietary fibre and 2.5-3.5 per cent minerals. Thirty sportswomen in the age group of 18 to 22 years were selected from Punjab Agricultural University, Ludhiana to determine the effect of supplementation of malted ragi (*Eleusine coracana*) beverage on nutritional status of sportswomen. During experimental period sportswomen were supplemented with 250 ml of most acceptable beverage for the period of four months. The results revealed that the developed beverage was having good amount of energy (218.19 kcal), protein (11.78 g), fat (6.81 g), calcium (172.6 mg), iron (3.73 mg) and phosphorus (102.2 mg) per 100 g. The mean daily food intake of cereals, pulses, roots and tubers, fruits, milk and milk products, fats and oils and sugars increased significantly ($p \leq 0.05$) after experimental period. Also significant increase was observed ($p \leq 0.05$) in the intake of energy, protein, carbohydrates, calcium, iron, phosphorus, vitamin A, folic acid and vitamin C after the experimental period. The increase in the haemoglobin, TIBC and serum calcium of the sportswomen after experimental period was increased to 12.30 g/dl, 457.01 µg/dl and 9.77 mg/dl, respectively. Therefore, ragi in malted form can be utilized for the development of highly nutritious beverage.

Key Words : Sportswomen, Malted ragi beverage, Supplementation, Nutrients, Haemoglobin, Nutraceutical

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INTRODUCTION

Sports persons have greater demands on the body as they are involved in physical strength, speed and endurance. Diet is of great importance to sports person that must fuel their bodies with the appropriate nutritional foods to meet their individual energy requirements in competition, training and recovery. If these nutritional needs are not met, there is an increased risk of poor performance, loss of muscle mass, menstrual malfunction, increased risk of osteoporosis, extended illness and fatigue. Female athletes are more prone to inadequate dietary intake as compared to male athletes. They need appropriate nutrition to uphold menstrual cycle and bone health. Inadequate dietary intake can have a huge impact on her physical performance as well as abnormal menstruation. Sometimes, for weight loss practices sports women undergo restricted energy diets or start taking in low or high carbohydrate diets having very low micronutrient composition which can cause severe

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micronutrient deficiencies. Sports women must ingest diets that at least fulfil the recommended dietary allowances for all micronutrients. Another major problem is dehydration. Sports person can lose between 2-3 litres of sweat during ninety minutes of intense workout particularly in hot and humid conditions. They can also lose as much as 2-3 kg of bodyweight during the same period. This amount of fluid loss can have a negative effect on their performance. After heavy training, adequate amount of fluid is essential to replace sweat loss and maintain electrolyte balance in the body.

All sports person look for the 'magic ingredient' to enhance their performance. These can be multivitamin capsules, energy drinks, energy bars or caffeinated drinks. These supplements can provide immediate energy to uphold the intense workout but they are not beneficial to sustain a healthy and long life. There is a need for a healthy substitute so that a sports women go on with her training and prolong a healthy life-style. A sports beverage incorporated with cereals, milk, fruits, honey and simple sugars to fulfil a part of sports person's nutritional requirements need to be developed. Sports beverage can be designed to replace the nutrient lost during exercise *i.e.* carbohydrates, fluids, electrolytes and vitamins with the main purpose of delaying fatigue. A beverage with a function of recovery drink can be milk based which contain nutrients like protein, carbohydrates, vitamins, minerals and water that are swiftly absorbed and metabolized by the body.

Now-a-days, there is a sudden increase in the demand of minor millets due to their health benefits and ragi is one of them. Ragi is a rich source of dietary fibre, calcium and phytochemicals with nutraceutical potential. Ragi contains about 5–8 per cent protein, 6–13 per cent fat, 65– 75 per cent carbohydrates, 15– 20 per cent dietary fibre and 2.5–3.5 per cent minerals. It has the highest calcium content among all cereals (344 mg/100 g). Ragi is a best source of micronutrients *i.e.* iron, phosphorus, zinc and potassium. The nutritive value of ragi is higher than that of rice and equal to that of wheat. Ragi also contains phytates (0.48%), polyphenols, tannins (0.61%) and trypsin inhibitory factors. The proportion of anti-nutritional factors can be lowered to permissible limits by applying pre-treatments like soaking, germination, roasting, malting, fermentation, extrusion technology and decortications, parboiling etc. By applying proper processing techniques, this low cost crop can be converted in to the various traditional and commercial value added products. Supplementation of beverage with malted ragi and exotic fruits can positively affect plasma lipid profile and antioxidant activity of sportswomen. So, keeping the above properties in view, the present study was planned with the objective to study the effect of supplementation of malted ragi beverage on the nutritional status of sportswomen.

METHODOLOGY

Selection of subjects:

A total of 30 sportswomen in the age group of 18-22 years were selected from Punjab Agricultural University, Ludhiana. They were selected on the basis of sports activity.

Collection of data:

Data was collected individually by interviewing the sportswomen and filled accordingly in the questionnaire.

General information:

The information collected by the questionnaire was pertaining to the age, family size, family income, religion, food habits, consumption of beverages, intake of supplements, intake of specific diet and menstrual cycle of the sportswomen.

Sports information:

The sport-wise distribution of sportswomen was: Basketball- 11, Table tennis- 5, Badminton- 5, Cycling- 4 and Athletics- 5.

Dietary survey:

Information regarding food preferences, beverage consumption pattern, meal pattern, food likes and dislikes and food fads and fallacies of the sportswomen was recorded. The dietary intake of sportswomen was recorded by "24 Hour Recall Method" for three consecutive days. The average daily intake of nutrients was calculated by using Diet Cal (Kaur, 2014). The mean daily nutrient intake was compared with the recommended dietary allowances for sportswomen given by ICMR (2010).

Anthropometric measurements:

The anthropometric measurements for height, weight, mid upper arm circumference and skinfold thickness were calculated by using standard methods given by Jelliffe (1966). All the above measurements were taken in pre

and post supplementation period. The bioelectrical impedance analysis was used for the measurement of skinfold thickness and harpenden skinfold callipers were used to measure mid arm muscle circumference in duplicate.

Body mass index:

Body Mass Index was calculated using the following formula given by (Garrow, 1981).

$$BMI = \frac{\text{Weight in kg}}{(\text{Height in meters})^2}$$

Waist and hip measurements:

The waist and hip measurements were recorded with the help of narrow, flexible and non-stretch fibre glass tape. Tape was placed gently and firmly around the waist line, hip, below the chest, above the stomach and measurements were recorded. With the above recorded measurements the waist hip ratio (WHR) was then calculated.

Body fat percentage:

It was calculated from the biceps, triceps, subscapular (SC) and suprailiac (SI) measurements using following equation given by Durnin and Womersley (1974):

Body density = D = 1.1549 - 0.0678 x Log (B+T+SS+ST)
(16-19 years)

Body density = D = 1.1599 - 0.0717 x Log (B+T+SS+ST)
(20-29 years)

Per cent body fat = (495 / Body density) – 450.

Blood profile:

The blood samples were collected to analyse the following parameters:

– Haemoglobin (Dacie and Lewis, 1975)
– Packed cell volume (Raghuramula *et al.*, 2003)
– Mean corpuscular volume (Dacie and Lewis, 1975)
– Total iron binding capacity (Teitz, 1976)
– Blood glucose (Nelson and Somogyi, 1944)
– Serum calcium level.

Supplementation of malted ragi beverage:

Study was divided into two periods *i.e.* control period and experimental period. All the observations were recorded before study, after one month of control period and after four months of experimental period. During one month of control period the subjects were observed without supplementation and during the experimental period the subjects were supplemented with 250 ml of developed functional beverage for a period of four months. The beverage was given two hours before their sport activity, five days a week.

Statistical analysis:

The data on all the parameters namely food and nutrition intake, anthropometric measurements and biochemical analysis of the sportswomen were analysed statistically. The mean, standard deviation, percentages, analysis of variance, two tail t-test and paired t-test were applied.

OBSERVATIONS AND ASSESSMENT

The collected information revealed that 67 per cent of sportswomen were 18-20 years of age and 33 per cent of sportswomen were 21-22 years of age. It was found that majority of the sportswomen *i.e.* 80 per cent belonged to Sikh community, 13 per cent were Hindu and 7 per cent were Muslim. Among all the sportswomen, there was not much deviation as 57 per cent were hostellers and 47 per cent were day scholars. As far as family system of the sportswomen was concerned, the data revealed that nuclear families (77%) dominated as compared to joint families (23%). Majority of the sportswomen *i.e.* 73 per cent had small size family with 2-5 members followed by large family size having more than five family members. Kaur (2009) reported that Punjab has highest percentage of adolescents (80%) that belonged to nuclear families while rest (20%) belonged to joint families. Chadda and Sinha (2013) compared the data of National Family Health Survey (NFHS) and reported a progressive increase in nuclear families among urban areas with an associated progressive decrease in the number of household members. Madankar (2014) reported that decreasing trend of joint families could be attributed to urbanization, modernization and globalization. The majority of sportswomen *i.e.* 93 per cent were having regular menstruation and 7 per cent of sportswomen were having irregular menstruation. During menstruation 43 per cent sportswomen suffered from problems, like low back pain (39 %), abdominal pain (46 %) and irregular period (15 %). Almost 57 per cent of sportswomen did not suffer from any problem during menstruation. It was observed that in the last six months 23 per cent

sportswomen fall sick while 77 per cent sportswomen did not fall sick. This could be due to proper dietary intake and strong immunity of the body. Kapoor (2012) reported that majority of adolescent girls (77%) had regular menstruation with 77 per cent girls having normal menstrual flow. The vitamin and mineral supplements were consumed by 17 per cent of sportswomen. These include mainly iron and calcium supplements. Very few sportswomen were following weekly fast *i.e.* 7 per cent and 93 per cent were not following any fasting days.

Sports information of the sportswomen:

With respect to information regarding sports activity Table 1 it was observed that majority of the sportswomen *i.e*. 36 per cent played basketball, 17 per cent of sportswomen were athletes, 17 per cent played badminton and 17 per cent played table tennis and 13 per cent were doing cycling. Almost 93 per cent of sportswomen played one to two hours daily and 7 per cent played for three to four hours daily. All sportswomen *i.e.* 100 per cent played for more than 3 days a week.

Dietary habits of the sportswomen:

The data indicated that out of all sportswomen, 50 per cent were non-vegetarian followed by 33 per cent ova vegetarian and 17 per cent vegetarian. Kapoor (2012) revealed the food habits of thirty adolescent girls and reported that 46 per cent of them were vegetarian and similar percentage was observed among non –vegetarian and ova –vegetarian *i.e*. 27 per cent. Out of all the sportswomen 23 per cent were having 1-3 meals per day and 77 per cent were having 4-6 meals per day. The meals were skipped by 43 per cent of sportswomen in a month and the meals were consumed on regular basis by 57 per cent of sportswomen. In majority the skipped meal was breakfast by 62 per cent of sportswomen followed by lunch *i.e.* 23 per cent of sportswomen and dinner by 15 per cent of sportswomen. From all the selected sportswomen, 40 per cent used to bring packed lunch with them and 60 per cent did not bring any packed lunch. These mainly include hosteller sportswomen who consume their lunch in their respective hostel mess. Narwal (2014) revealed that sports women had average nutritional knowledge and food requirements and they follow vegetarian food habits. In the another study forty healthy resistance-trained individuals (11 female, 29 male) participated to determine the effects of a very high protein diet Antonio *et al.* (2014). Data regarding food likes and dislikes revealed that 17 per cent liked and 83 per cent of the sportswomen disliked fast food. On the other hand 77 per cent sportswomen liked sweet foods and 23 per cent sportswomen disliked sweet foods. In

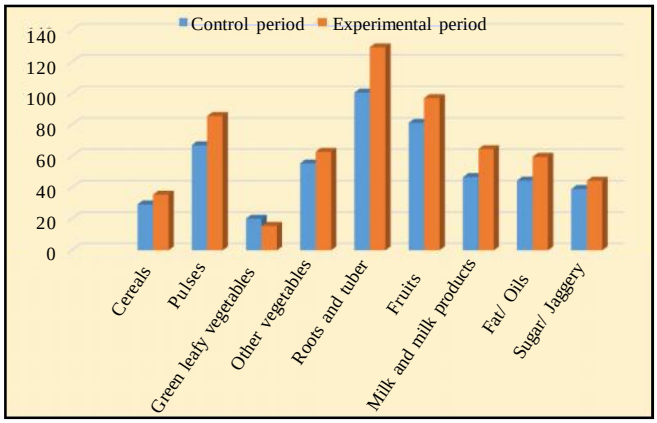

Fig. 1 : Per cent adequacy of food intake among sportswomen

Table 1: Impact of supplementation of malted ragi beverage on mean daily food intake of sportswomen

Food groups	Control period	Experimental period	t-value	Per cent adequacy		Suggested dietary intake # (g)
				Control period	Experimental period	
Cereals	161.45±43.6	195.57±45.89	7.67*	29.3	35.5	550
Pulses	53.60±16.64	68.55±17.05	5.55*	67	85.6	80
Green leafy vegetables	30.33±51.16	23.33±43.97	1.03^{NS}	20.22	15.5	150
Other vegetables	110.86±64.51	125.67±70.25	1.37^{NS}	55.43	62.83	200
Roots and tuber	150.84±84.31	194.13±120.40	3.46*	100.5	129.42	150
Fruits	121.80±73.02	145.50±95.70	1.88*	81.2	97	150
Milk and milk products	350.17±167.81	484.17±198.43	5.17*	46.6	64.5	750
Fat/ Oils	33.35±11.72	44.75±15.33	4.76*	44.5	59.6	75
Sugar/ Jaggery	31.33±10.14	35.50±8.92	3.48*	39.1	44.3	80

* indicate significance of value at P=0.05 # ICMR 2010 NS = Non - significant

the same way 67 per cent sportswomen liked salty foods and 33 per cent sportswomen disliked salty foods. Fried food was liked by 37 per cent and disliked by 63 per cent of sportswomen. The homemade food was liked by 100 per cent of sportswomen. Data regarding beverage likes and dislikes revealed that 67 per cent sportswomen liked traditional beverages while 33 per cent sportswomen disliked traditional beverages. Soft drinks were liked by 60 per cent sportswomen and disliked by 40 per cent sportswomen. On the other hand energy drinks were liked by 33 per cent sportswomen and disliked by 37 per cent sportswomen. The juice consumption was liked by 100 per cent sportswomen.

Impact of supplementation of malted ragi beverage on mean daily food intake of sportswomen:

The mean daily food intake of the sportswomen during the control and experimental period is given in Table 1. The most commonly consumed cereals among sportswomen were wheat and rice. Wheat being the staple cereal was consumed in the form of chapatti, *Parantha* and bread. On the perusal of data it was revealed that there was significant increase ($P \leq 0.05$) in the intake of cereals after four months supplementation in the sportswomen. A study conducted by Vasanthamani and Anuradha (2011) have reported that intake of cereals was ten percent deficit among female athletes of 18-23 years of age. Similarly, Kaur (2009) reported the lower intake of cereals in the adolescent girls *i.e.* 236±4.73 g. Commonly consumed pulses were green gram, rajmah, lentil and bengal gram. The data revealed that mean daily intake of pulses of the sportswomen during control and after experimental period was 53.6±16.64 and 68.55 ±17.05 g, respectively that was less than the reference value of 80 g by ICMR (2010). However, there was significant increase ($P \leq 0.05$) in the intake of pulses after four months supplementation in the sportswomen. Kaur (2009) reported the lower mean daily intake of pulses by the adolescent girls.

In the present study the data revealed that the mean daily intake of green leafy vegetables of the sportswomen was 30.33±51.16 g/day during the control period and 23.33±43.97 g/day after supplementation period. The average daily intake of other vegetablesby the sportswomen was observed to be 110.86±64.51 g during the control period and 125.67±70.25 g after supplementation period. The average daily intake of roots and tubersby the sportswomen was observed to be 150.84±84.31 g/day during the control period. After supplementation period the corresponding figure was increased to 194.13±120.40 g/day. It was observed that the intake of roots and tubers was 129.42 per cent adequate after the experimental period. This could be due to more consumption of potatoes, onion and carrot in the form of cooked vegetables, salads and snacks. In the similar study, Kaur (2009) reported inadequate consumption of roots and tubers by the adolescent girls i.e. 86±2.54 g. The mean daily intake of fruitsby the sportswomen was observed to be 121.80±73.02 g during the control period and 145.50±95.70 g after supplementation period. The intake of fruits was found to be 97 per cent adequate after the experimental period that was improved after the supplementation of malted ragi beverage.

The data revealed that the average daily intake of milk and milk products of the sportswomen was 350.17±167.81 g and 484.17±198.43 g during control and after experimental period. The intake of milk was 64.5 percent adequate after the experimental period as compared to control period during which the adequacy was 46.6 per cent. Batra (2009) reported that intake of milk and milk products was 87 and 99 per cent among non-vegetarian and vegetarian adolescent girls of Ludhiana. The data revealed that the mean daily intake of fats and oils by the sportswomen was 33.35±11.72 g/ day during the control period and 44.75±15.33 g/day after supplementation period. Kaur (2009) reported the intake of fats and oils in the adolescent girls *i.e.* 23.3±0.44 g. The average daily intake of sugar and jaggery by the sportswomen was 31.33±10.14 g/day during the control period. After supplementation period the corresponding figure was 35.5±8.92 g.

Impact of supplementation of malted ragi beverage on mean daily intake of nutrients:

The mean daily intake of energy, carbohydrates, protein and fat during the control and experimental period is given in Table 2. Ferranti *et al.* (2015) evaluated the food and nutritional status of twenty-one athletes and revealed that calories, carbohydrates, calcium, vitamins A and C values were below the recommended level ($p < 0.05$). The data revealed that the mean daily intake of energy by the sportswomen was increased after experimental period (2063±538.36 Kcal/day) as

compared to control period (1677±756.7 Kcal/day). A significant increase (P≤0.05) in the intake of calories was observed after experimental period. The per cent adequacy of the energy was observed to be inadequate both in control as well as experimental period *i.e.* 37.26 and 45.8 per cent, respectively. Narayanan and Rathi (2015) reported the energy intake of 10-12 year old girls was 60.89 per cent and it was 64.90 per cent in 13- 15 years old girls. Kam *et al.* (2016) reported that the most important nutritional need for sports women is to meet the energy demands throughout their training sessions. The mean daily intake of carbohydrates of the sportswomen was 235.78 g/day during the control period. After supplementation period the corresponding figure was significant increase (P≤0.05) to 283.04 g/day. Narayanan and Rathipriya (2015) reported the carbohydrates intake of adolescent girls (13- 15 years) was 210.46 ±51.47.

The data revealed that the mean daily intake of protein of the sportswomen was significant increase (P≤0.05) from 53 g/day during the control period to 80 g/day after supplementation period. The intake of protein was observed to be 50 per cent adequate after the experimental period. Deldicque and Francaux (2015) recommended protein intake of 1.6 g/kg/day by female athletes instead of 1.2–1.4 g protein/kg/day. Parimalavalli and Sangetha (2011) reported that intake of protein by government and private school going girls was 48.9 and 56 g, respectively. The mean daily intake of fat by the sportswomen was observed to be 58.2±32.23 g during the control period and 68±30.23 g after the supplementation period.

Impact of supplementation of malted ragi beverage on mean daily intake of minerals and vitamins is given in Table 3. The data revealed that the mean daily intake of calcium of the sportswomen was 819.51 mg/day during the control period. After supplementation period the corresponding figure was 1036.11 mg/day. Significant increase (P≤0.05) was observed in the intake of calcium after four months supplementation in the sportswomen. The per cent adequacy of the intake of calcium was reported to be 40.97 per cent during control period and 51.81 per cent during experimental period. Baker *et al.* (2011) reported that increased exercise lead to raised level of calcium loss due to high sweat and urine output.

The mean daily intake of iron of the sportswomen was 11.86 mg/day during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 14.29 mg/day. It was seen that the intake of iron was 23.81 per cent adequate after the experimental period. Selvarani (2017) reported that the most prevalent nutritional problem worldwide is anaemia which is caused due to nutritional deficiency. The most common type of anaemia affecting

Table 2 : Impact of supplementation on mean daily intake of nutrients

Nutrients	Control period	Experimental period	t value	Per cent adequacy		RDA #
				Control period	Experimental period	
Energy, Kcal	1677±756.7	2063±538.36	2.301*	37.26	45.8	4500
Carbohydrate, g	235.78±104.42	283.04±77.67	2.06*	-	-	-
Protein, g	53.10±16.46	80.21±13.86	4.51*	33.18	50	160
Fat, g	58.20±32.23	68±30.23	1.55 NS	48.5	56.6	120

* indicate significance of value at P=0.05 # ICMR 2010 NS= Non- significant

Table 3: Impact of supplementation on mean daily intake of minerals and vitamins

Nutrients	Control period	Experimental period	t value	Per cent adequacy		RDA #
				Control period	Experimental period	
Calcium, mg	819.51±247.41	1036.11±383.73	2.44*	40.97	51.81	2000
Iron, mg	11.86±2.74	14.29±3.58	2.78*	19.76	23.81	60
Phosphorus, mg	1209±464.11	1508.66±509.52	2.26*	201.5	251.44	600
β- Carotene, µg	1182.91±1785.81	1018.55±1521.96	0.37 NS	24.64	21.22	4800
Vitamin A, µg	241.53±96.46	280.39±137.55	1.25 NS	40.25	46.73	600
Folic Acid, µg	136.19±62.01	186.90±97.41	2.14*	68.09	93.45	200
Vitamin C, mg	106.91±106.91	115.86±80.07	0.32 NS	267.27	289.66	40

* Values are significant at 5% level # ICMR 2010 NS = Non - significant

55.8 per cent of adolescent girls is iron deficiency anaemia. The data revealed that the mean daily intake of phosphorus of the sportswomen was 1209 mg/day during the control period which was significantly increased (P≤0.05) to 1508.66 mg/day. The mean daily phosphorus intake of the sportswomen before and after experimental period was more than the reference value of 600 mg by ICMR (2010). The intake of phosphorus was observed to be more than adequate after the experimental period *i.e.* 251.44 per cent. The mean daily intake of β- carotene of the sportswomen was 1182.91 µg/day during the control period. After supplementation period the corresponding figure was 1018.55 µg/day. The mean daily intake of β-carotene by the sportswomen before and after experimental period was less than the reference value of 4800 µg by ICMR (2010). There was decrease in the intake of β- carotene after supplementation in the sportswomen. It could be due to the seasonal variation of fruits and vegetables. The intake of β- carotene was 21.22 per cent adequate after the experimental period.

The data revealed that the mean daily intake of vitamin A of the sportswomen was 241.53 µg/day during the control period which was significantly increased (P≤0.05) to 280.39 µg/day after supplementation period. The intake of vitamin A was 46.73 per cent adequate after the experimental period. The mean daily intake of folic acid by the sportswomen before and after experimental period was less than the reference value of 200 µg by ICMR (2010). It was observed that the intake of folic acid was 136.19 µg/day during the control period and 186.9 µg/day after supplementation of malted ragi beverage that was significant increase (P≤0.05). The intake of folic acid was seen to be 93.45 per cent adequate after the experimental period. Lower intake of folic acid was observed among adolescent girls by Singla (2011) and Batra (2009). The data revealed that the mean daily intake of vitamin C of the sportswomen was 106.91 mg/day during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 115.86 mg/day.

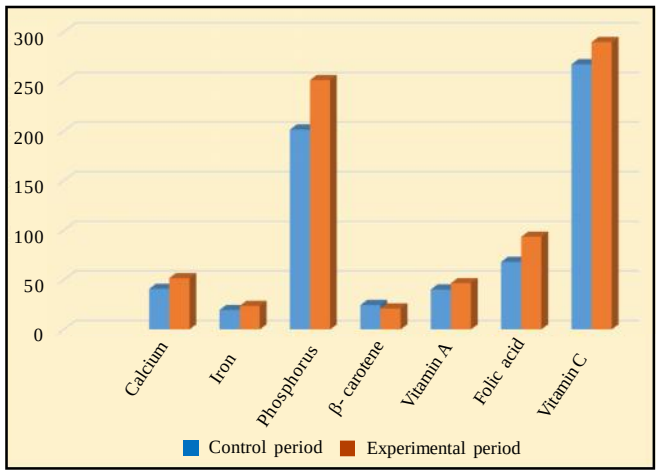

Fig. 2: Per cent adequacy of nutrient intake among sportswomen

Impact of supplementation of malted ragi beverage on anthropometric measurements of the sportswomen:

Measurement of growth has been a widely used tool for the assessment of health and nutritional status of sportswomen. The anthropometric profile of the sportswomen is given in the Table 4. Ferranti *et al.* (2015) evaluated the anthropometric profile of twenty-one athletes that included weight, height, body mass index, arm circumference, skin folds and bio impedance and revealed that the mean body fat percentage was above 17 per cent. The average basal metabolic rate was 1.921.77±171.23 kcal and total energy expenditure of 3.418.10±321.63 kcal.

The mean height and corresponding figures after supplementation period was 156.4 cm. There was no significant change in the height of the sportswomen. Kaur (2017) reported that there was not any significant

Table 4 : Impact of supplementation of malted ragi beverage on anthropometric measurements of the sportswomen

Anthropometry	Control period	Experimental period	t value	Standard values
Height, cm	156.4±3.00	156.4±3.00	0.00 ^{NS}	162 #
Weight, kg	58.46±6.71	56.73±5.55	1.02 ^{NS}	53 #
BMI, kg/m²	24.89±4.98	23.21±2.25	1.60 ^{NS}	18.5- 24.99 «
MUAC, cm	27.26±2.99	26.70±2.76	0.66 ^{NS}	29.1 ^{a}
Waist hip ratio	0.83±0.02	0.82±0.03	0.56 ^{NS}	0.8
Body fat %	21.6±4.36	21.6±4.36	0.00 ^{NS}	14- 20

NS= Non- significant # ICMR 2004 ^{a} Jelliffe (1966) « WHO 2004

difference in the height, weight and body mass index (BMI) of vegetarian and non-vegetarian subjects of both the genders. The mean weight of the sportswomen during control period and experimental period was 58.46 and 56.73 kg, respectively. The weight was more than the reference weight given by ICMR (2004). However, there was non-significant decrease in the weight of the sportswomen before and after supplementation period. Kaur (2002) reported the mean weight of the sportswomen ranged from 4.0 to 75.0 kg with the mean value of 58.3 kg.

The data revealed that the mean body mass index of the sportswomen was 24.89 kg/m² during the control period. After supplementation period the corresponding figure was 23.21 kg/m². The body mass index of the sportswomen before and after supplementation period was in the normal range of 18.5-24.99 kg/m² WHO (2004). The data revealed that the mean mid upper arm circumference of the sportswomen was 27.26 cm during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 26.7 cm. The mid upper arm circumference of the sportswomen before and after supplementation period was in the normal range given by Jelliffe (1966).

The mean waist hip ratio of the sportswomen was 0.83 during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 0.82. The waist hip ratio of the sportswomen before and after supplementation period was slightly above the normal range of 0.8. The data revealed that the mean body fat percentage of the sportswomen during the control period and after supplementation period was 21.6. No change was observed in mean body fat percentage of the sportswomen. Kaur (2002) reported that the per cent body fat of sportswomen was less than the mean value of 27.5 for the non-sportswomen.

Impact of supplementation of malted ragi beverage on the biochemical profile of the sportswomen:

The data pertaining to haematological profile of the sportswomen is given in Table 5. Shalesh *et al.* (2014) supplemented sports drink (Pocari Sweat) to evaluate its effect on male soccer players and revealed that there was a significant difference in the values of blood pressure, heart rate and blood electrolyte in the favour of the group which have given sports drink.

The data revealed that the mean haemoglobin of the sportswomen during the control period was 11.65 g/dl that was increased significantly after supplementation period with the corresponding figure of 12.3 g/dl. The per cent change was observed to be 5.58 per cent before and after supplementation of malted ragi beverage to the sportswomen. The haemoglobin of the sportswomen was slightly above the normal range after the supplementation period. Kapoor (2012) reported that the mean heamoglobin of the subjects in control and experimental group increased to 9.99±0.12 and 10.51±0.15 g/dl in control and experimental group, respectively. Singla (2011) also reported a haemoglobin level of 10.97 and 9.14 g/dl, respectively, in adolescent girls. Batra (2009) also reported that the mean heamoglobin level was 9.9±1.0 and 10.7±0.09 g/dl in vegetarian and non-vegetarian girls. Koehler *et al.* (2012) reported that although density of dietary iron among female athletes was higher than male athletes but most of them failed to achieve the recommended dietary allowance for iron. Depletion of iron was seen more among female athletes (57%) as compared to male athletes were at the higher risk of developing iron deficiency due to increased iron losses through menstruation and exercise-induced mechanisms associated with endurance activity. So it is important to create awareness about the intake of diets rich in iron.

The mean packed cell volume of the sportswomen was observed to be 35.43 per cent during the control

Table 5 : Impact of supplementation of malted ragi beverage on biochemical profile of the sportswomen

Blood profile	Control period	Experimental period	t value	Normal range
Haemoglobin, g/dl	11.65±0.82	12.30±0.89	2.57*	> 12 «
PCV, %	35.43±2.52	36.63±3.01	1.55 NS	37-44 •
MCV, fl	76.24±8.51	80.37±7.51	2.12*	77-95 •
TIBC, µg/dl	372.32±79.52	457.01±67.29	4.79*	250-416 [a]
Serum calcium, mg/dl	9.07±0.85	9.77±0.56	4.37*	8.7-11 ®
Blood glucose mg/dl	78.06±7.99	84.93±11.84	2.41*	< 200 ∞

* indicate significance of value at P=0.05 NS = Non- significant « : WHO 2001 • : Dacie and Lewis (1975) [a] : Goodhart and Shills (1980)
® : Burtis *et al.* (2008) ∞ : Raghuram *et al.* (2007)

period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 36.63 percent. The packed cell volume of the sportswomen before and after supplementation period was in the normal range of 37-44 per cent. Kapoor (2012) reported the mean packed cell volume among adolescent gilrs was 32.99±0.52 in control group and 34±0.39 per cent in experimental group. Kaur (2009) also reported that the mean PCV values in adolescent girls were 32.5±0.55 which was comparable to the present study. The mean corpuscular volume of the sportswomen during the control period was 76.24 fl. Alaunyte *et al.* (2015) reported that female athletes indulging in intense sport exercises was increased significantly after supplementation period with the corresponding figure of 80.37 fl. The per cent change was observed to be 5.42 per cent before and after supplementation of malted ragi beverage to the sportswomen. The mean corpuscular volume of the sportswomen was in the normal range after the supplementation period. Kaur (2009) conducted a study in Ludhiana and reported the MCV values of 85.52 fl and 86.90 fl.

The mean TIBC of the sportswomen was 372.32 ug/dl during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 457.01 ug/dl. The TIBC of the sportswomen after supplementation period was above the normal range of 250-416 ug/dl. There was significant increase in the TIBC of the sportswomen with the per cent increase of 22.75 per cent after the supplementation of malted ragi beverage. Kapoor (2012) reported a significant ($p \leq 0.05$) change in the TIBC of the subjects after the supplementation. It was observed that the TIBC value was in the normal range of 263.13±8.52 and 279.2±10.37 µg/ dl in control and experimental group, respectively. The data revealed that the mean serum calcium content of the sportswomen during the control period and after supplementation period was 9.07 and 9.77 mg/dl, respectively. There was significant increase in the serum calcium of the sportswomen with the per cent increase of 7.7 per cent after the supplementation of malted ragi beverage.

Samozai and Kulkarni (2015) reported that in spite of consuming calcium supplements, the serum calcium levels did not vary significantly whereas the urinary calcium levels increased progressively (p value < 0.005) in those who have taken calcium supplements for a year compared to those who have taken for a month.

Blood glucose:

The mean blood glucose of the sportswomen was 78.06 mg/dl during the control period. After supplementation of malted ragi beverage to the sportswomen the corresponding figure was 84.93 mg/dl. The blood glucose of the sportswomen before and after supplementation period was in the normal range given by Raghuram *et al.* (2007).

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