Linkage of concepts of good nutrition in yoga and modern science

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According to the yogic concept of nutrition, food has been categorized as Sattvic (pure), Rajasic (over-stimulating) and Tamasic (dull) with respect to its effect on the body and mind. Modern science emphasizes the importance of diet rich in micronutrients and low in fats and cholesterol for greater health attributes. The present investigation was carried out to examine how far the two concepts are similar and also their effects on physical and mental health. A database of nutrient contents of 110 cooked food items was cross-classified with their gunas as Sattvic, Rajasic and Tamasic, and their micronutrient density or fat density. Observations on daily diet by 24-h recall, blood levels of haemoglobin, lipids, superoxide dismutase (SOD), lipid peroxidation as MDA, and anxiety, patience and stress scores were recorded for 109 apparently healthy individuals. A significant correlation of yogic classification was found with micronutrient density ($r = 0.533$, $P = 0.0001$) and fat density of food ($r = -0.51$, $P = 0.0001$). In adults dietary intake of micronutrients showed significant positive correlation ($r = 0.31$–0.7) with Sattvic food intake. However, Rajasic food intake was correlated with only thiamin ($r = 0.47$) and Tamasic food intake only with zinc ($r = 0.23$) and iron ($r = 0.3$). Correlation between Tamasic food intake and anxiety was statistically significant ($r = 0.37$, $P = 0.004$). Thus, Sattvic food was high in micronutrient density and low in fat content, while Tamasic food was low in micronutrient density and high in fat content. Diet showed significant impact on mental status of adults, supporting the diet–mind inter-relationship concept of yoga.

Keywords: Rajasic, Sattvic, Tamasic, yoga.

YOGA emphasizes an intimate connection of diet with the mind, because the mind is formed from the subtlest portion of the essence of food. According to the yogic concept of good nutrition, diet is of three kinds: Sattvic (pure), Rajasic (over-stimulating) and Tamasic (dull) with respect to its effect on the body and mind. Sattvic diet is supposed to increase the energy of the mind and produce cheerfulness, serenity and mental clarity. Rajasic food creates jealousy, anger, delusion, fantasies and egotism. Tamasic food increases pessimism, laziness and doubt. Sattvic food is fresh, juicy, light, unctuous, nourishing and tasty. Rajasic food is bitter, sour, salty, pungent, hot and dry. Tamasic foods are stale, heavy, half-cooked or overcooked[1]. Generally, Sattvic food includes dairy products, fresh fruits and vegetables, while bitter, sour, salty and pungent food, white sugar, radish and deep fried food are known as Rajasic. Beef, pork, intoxicants, drugs, stimulants, garlic, onion, stale, rotten and unclean food, half-cooked or twice-cooked food and mushroom, etc. are Tamasic[2].

Current nutritional knowledge lays emphasis on micronutrient quality of diet with less fat and high fibre. Fried and stale food, as also smoking, pollution, etc. are known to produce excessive free radicals in the body leading to numerous diseases like cardiovascular, respiratory, cancer and arthritis. Eating food rich in antioxidants like zinc, vitamin E, vitamin C and b-carotene may reduce oxidative stress. It is worthwhile to enumerate the micronutrients, fat and fibre contents of commonly consumed food and examine their similarity with the yogic concept of classifying food. Further, influence of certain micronutrients on brain function has been reported[3]. In the present study, association of psychological performance of adults with type of food and level of micronutrients was evaluated to examine the mind–body effect of diet.

In our earlier studies we have estimated nutrient content of cooked food[4,5]. Macronutrients were estimated by proximate principles analysis, while fibre was estimated independently by modified detergent method[6]. Vitamins and minerals were determined using the NIN manual[7]. This database of nutrient contents of around 110 commonly consumed food items was classified according to the yogic concept, i.e. Sattvic, Rajasic and Tamasic[2].

Contents of energy, protein, fat, zinc, copper, iron, riboflavin, thiamin, folic acid, vitamin C and b-carotene from our database are given as nutrients per 100 g cooked food categorized into different food groups (Table 1). Total micronutrients content of 100 g cooked food was obtained by addition of the above micronutrients in micrograms. Micronutrient density is the amount of total micronutrients in μg/total calorie content. The rationale used in cross-classification of micronutrient density with type of food was based on the pooled Recommended Dietary Allowances (RDA) of eight micronutrients given for Indians by ICMR for a reference adult male[8], expressed as per RDA of energy. Mean micronutrient density was 31.5 ± 4.7. Low range corresponded to values less than mean – 3 SD, medium range corresponded to mean ± 3 SD and high range corresponded to values greater than mean + 3 SD.

Fat density was computed as amount of total fat in mg/total calorie content. Cross-classification of fat density with type of food was based upon guidelines for per cent contribution of energy from fat to be less than 30% using the food pyramid concept by USDA[9].

Fibre density was calculated similar to that of fat density, viz. amount of fibre in mg/total calorie content of each food.

One hundred and five apparently healthy adults (20–55 yrs) participated voluntarily in the study. Daily diet was recorded by 24-h recall on two nonconsecutive days

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Table 1. Mean nutrient contents of cooked food items per 100 g

Nutrient	Cereal preparations (*n* = 15)	Legume preparations (*n* = 16)	Snacks (*n* = 39)	Green leafy vegetables (*n* = 15)	Other vegetables (*n* = 16)	Fruits (*n* = 9)
Moisture (g)	41.3 ± 4.4	82.4 ± 1.5	40.1 ± 4.3	65.7 ± 5.3	73.6 ± 3.0	81.6 ± 1.6
Energy (kcal)	269 ± 18	77 ± 7	331 ± 28	124 ± 13	118 ± 13	74 ± 9
Protein (g)	6.5 ± 0.6	2.7 ± 0.3	6.5 ± 1.0	1.9 ± 0.3	2.4 ± 0.2	0.6 ± 0.2
Fat (g)	8.4 ± 1.0	1.8 ± 0.2	14.3 ± 1.8	1.9 ± 0.2	3.1 ± 0.4	0.06 ± 0.04
Carbohydrate (CHO) (g)	43.6 ± 3.3	13.6 ± 8.8	36.0 ± 2.2	25.2 ± 2.6	21.2 ± 1.7	3.97 ± 1.7
Total fibre (g)	4.8 ± 0.76	0.72 ± 0.06	1.9 ± 0.25	1.14 ± 0.19	0.88 ± 0.13	3.1 ± 1.2
b-Carotene (μg)	142 ± 37	108 ± 11	140 ± 27	1600 ± 381	170 ± 27	202 ± 166
Vitamin C (mg)	2.4 ± 0.8	3.5 ± 0.8	3.6 ± 0.7	10.6 ± 2.0	7.8 ± 1.0	16.4 ± 7.8
Riboflavin (μg)	51 ± 7	21 ± 5	47 ± 9	16 ± 3	22 ± 4	18 ± 2
Thiamin (μg)	150 ± 28	18 ± 4	118 ± 20	40 ± 5	36 ± 6	28 ± 5
Folic acid (μg)	10.0 ± 1.8	5.1 ± 0.9	4.7 ± 1.2	17.0 ± 3.7	9.8 ± 1.1	7.6 ± 1.2
Zinc (mg)	1.0 ± 0.1	0.46 ± 0.07	1.1 ± 0.1	0.40 ± 0.1	0.20 ± 0.04	0.2 ± 0.01
Copper (mg)	0.22 ± 0.03	0.16 ± 0.02	0.25 ± 0.03	0.05 ± 0.02	0.07 ± 0.003	0.05 ± 0.03
Iron (mg)	1.9 ± 0.3	0.75 ± 0.1	2.7 ± 0.04	0.8 ± 0.1	0.20 ± 0.05	0.3 ± 0.08

of a week. Nutrient intake was computed using our database of laboratory estimates of cooked food.

For psychometric observations, Spielberger's State and Trait Anxiety score, stress scale and patience scale were administered.

The Spielberger State–Trait Anxiety Inventory (STAI)[10] is a 40-item, self-report questionnaire providing two measures of anxiety – state anxiety and trait anxiety. Trait anxiety refers to how anxious a person characteristically feels, while state anxiety refers to how anxious a person feels at any given moment. A higher score indicates greater anxiety. Both state and trait anxiety scales have been shown to have high reliability with median *a*-coefficients of 0.92 and 0.90. While the state anxiety scale demonstrates variability over time, test–retest reliability for the trait portion of the scale ranges from 0.73 to 0.86. Scores range from 40 to 160.

The patience scale is a test of 10 min with 15 questions, based on responses to different daily situations. Patience is defined as calmness, self-control and willingness or ability to tolerate delay. Impatience, on the other hand, is defined by time-urgency and the inability to tolerate slow people or processes. Impatient people tend to overreact to stress.

Stress is imbalance between demand (physical or psychological) and response capability under particular conditions. The stress scale is a self-report rating the scale of current life-stressors. The scale contains 20 commonly experienced stressors (both eustress and distress items), and respondents are instructed to indicate which stressors they have experienced over the course of the past six months. Items from the questionnaire include the following: (a) death of family member or friend, (b) work for more than 8 h a day, (c) no sleep, (d) small loan, (e) minor violation of law, and (f) outstanding personal achievement. Items are assigned scores and the number of items endorsed is tallied to create a total score.

Assessment of blood pressure, morbidity during the last one month, current health complaints, weight, height and waist–hip circumference were recorded by a medical doctor.

Fasting blood samples of 10 ml were taken and analysed for levels of glucose, lipids, zinc, superoxide dismutase (SOD) and Malon dialdehide adducts (MDA). Total cholesterol, triglycerides and glucose have been estimated using standard kits (Ranbaxy, India), and plasma zinc and iron by atomic absorption spectrophotometry (UNICAM, UK). SOD was estimated according to the method of Beauchamp and Freidowich[11] and MDA was estimated by the method of Kaur *et al.*[12].

All analyses were done using SPSS version 11.0. Comparison of two methods of classification was done by chi-square test. Differences between means were tested by Student's *t* test. Pearson correlation coefficient was computed to quantify association between two variables.

Table 2 shows different food items as Sattvic, Rajasic and Tamasic vs micronutrient density of foods being low, medium and high. There were 24 items, which were a combination of two groups, e.g. sweet lassi was Sattvic as well as Rajasic, misal was Tamasic and Sattvic, pavbhaji was Rajasic and Tamasic. Such items were excluded while making the comparison. Our data showed that around 50% Tamasic food was low in micronutrients content, 58.3% Rajasic food had medium micronutrients content and 67.3% Sattvic food was rich in micronutrients (Figure 1). Significant positive association was found between the classification based on micronutrient density and yogic approach ($r = 0.533$, $P = 0.0001$). Cross-classification of fat density and type of food showed that 18% Sattvic food items were high in fat, whereas 42% Rajasic and 72% Tamasic food items were high in fat (Figure 2). There was a significant negative correlation between the two methods of classification ($r = -0.45$, $P = 0.0001$).

Table 2. Yogic classification of food vs micronutrient density (µg per kcal)

Micronutrient density	Tamasic	Rajasic	Sattvic
Low (0.3–15.2)	Biscuit, fermented rice flour with jaggery and ghee (anarasa), achar, wafers	Coffee, tea, sherbet, jam, puri, pancake of split Bengal gram, jaggery, wheat (puranpoli), fermented and fried refined wheat flour rolls, sweets (jilebi), ice cream, chocolate	Rice, ghee
Medium (16–46)	Mixture of fried lentil, pulses (pharasan), mixture of puffed rice with pharsan, peanut, onion, tomato, jaggery, tamarind chilli (bhel), fried rolls of mixed grains (rice, wheat, bajra, jowar) flour (chakli, bakarwadi)	Peanut–jaggery balls, curds with rice flakes, semolina with ghee, sugar (shira/suji), salty semolina (upma), sago–peanut–ghee (sago khichadi), samosa, shallow-fried pancake of cereal and legume flours (thalipeeth), patties, onion pakoda, fried balls of fermented split black gram (medu wada)	Milk, steamed rice flakes with onion (kandapohe), idli, curds, chapati, sorghum roti, pearl millet roti, onion stalks, ambadi, split red gram, split Bengal gram, field beans, French beans, apple, potato
High (48–1474)	Egg, meat	Rice–split black gram shallow-fried pancake (uttappa)	Sprouted beans, fenugreek leaves, pumpkin, brinjal, guava, custard apple, papaya, cabbage, shepu, colocassia, flower, bottle gourd, cluster beans, tondli, snake gourd, buttermilk with split Bengal gram flour (kadhi), beet, cucumber, tomato, carrot, raddish, rice with split green gram (mung-khichadi), spinach, amaranth, capsicum, bitter gourd, ridge gourd, lady's finger, banana, pomegranate.

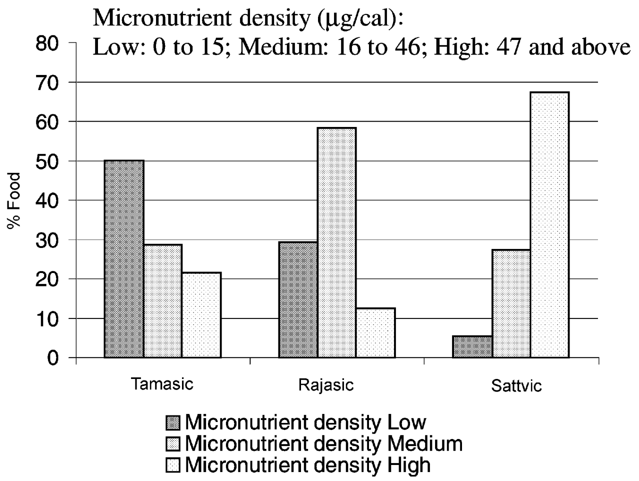

Figure 1. Comparison of yogic concept of diet with micronutrient density of food.

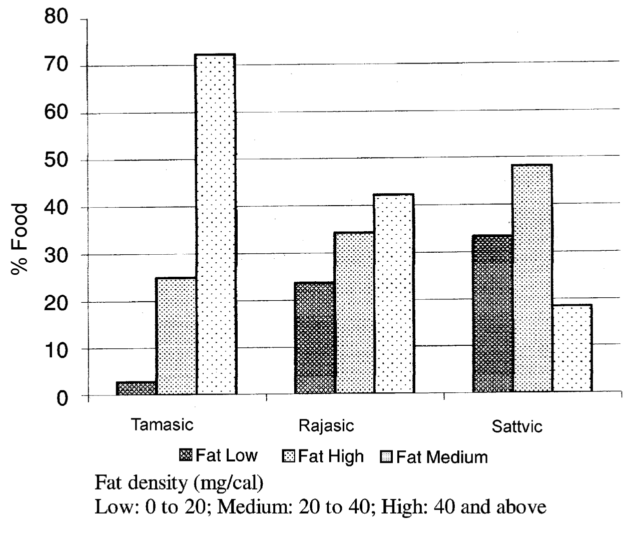

Figure 2. Comparison of yogic concept of diet with fat density of food.

Average fibre density was similar in Sattvic (15.6 ± 2.4 mg/kcal), Rajasic (14.7 ± 2.1 mg/kcal) and Tamasic food (13.2 ± 1.6 mg/kcal). There was no significant association between fibre density of food with yogic type, viz. Sattvic, Rajasic and Tamasic.

Linkage of the modern and yogic concepts of good nutrition for daily food intake in adults was examined. Table 3 gives the general characteristics of the subjects. Average age of the subjects was 35 years. About 38.3% men and 17.4% women had BMI above 25. Four women and eight men had borderline high blood pressure. All the subjects had their fasting glucose and triglycerides within normal range. Except two men and two women, total cholesterol was within normal range for all subjects. Three men and six women had low haemoglobin status. These subjects[19] were excluded from statistical analysis.

There was no association between age and intake of Sattvic, Rajasic or Tamasic food, as also with nutrient intake in our study group. Therefore, analysis was carried for the entire age range.

Table 4 gives nutrient intake of the subjects. Average protein intake was slightly lower than the RDA for Indian adults[8], while mean fat intake was higher than the RDA. Average intake of *b*-carotene, riboflavin, thiamin, zinc and iron was 40–60% lower than the respective RDA. Average intake of vitamin C, niacin and copper was similar to RDA.

Mean dietary intake of Sattvic food was 866 g/day in men and 737 g/day in women. Mean Rajasic food intake was lower (87 g/day and 34 g/day in men and women respectively) than that of Tamasic food (224 g/day in men and 202 g/day in women).

Table 3. Characteristics of the subjects

Parameter	Men	Women
Age (yrs)	35.9 ± 1.6	34.1 ± 2.1
Weight (kg)	66.3 ± 1.2	54.2 ± 1.9
Height (cm)	166.9 ± 1.1	157.1 ± 1.0
BMI (kg/m^2)	23.8 ± 0.45 (18–25)	21.5 ± 0.8 (18–25)
Waist–hip ratio	0.89 ± 0.01 (<1)	0.77 ± 0.01 (<0.8)
Systolic blood pressure (Hg/mm)	127 ± 2 (120)	117 ± 2 (120)
Diastolic blood pressure (Hg/mm)	84 ± 1 (80)	80 ± 2 (80)
Hb (g/dl)	13.6 ± 0.2 (14–16)	11.2 ± 0.3 11.3 (12–14)
Glucose (mg/dl)	95 ± 1 (60–120)	94 ± 1 (60–120)
Total cholesterol (mg/dl)	136 ± 9 (150–250)	137 ± 10 (150–250)
Triglycerides (mg/dl)	98 ± 2 (60–165)	97 ± 3 (40–140)
SOD (u/ml cells)	0.95 ± 0.01	0.96 ± 0.02
Plasma zinc (μg/ml)	0.85 ± 0.01 (0.7–1.1)	0.83 ± 0.02 (0.7–1.1)
Plasma iron (μg/ml)	0.76 ± 0.01 (0.75–1.75)	0.74 ± 0.03 (0.75–1.75)
Plasma MDA (nanomols/ml)	5.5 ± 0.2	5.9 ± 0.23

Figures in bracket represent normal values (Documenta Giegy).

Table 4. Mean daily nutrient intake of subjects

Nutrient	Men	Women
Energy (kcal)	2354 ± 501	1858 ± 390
Protein (g)	44.0 ± 2.0	42.0 ± 9.0
Fat (g)	60.0 ± 3.2	62.8 ± 13.9
CHO (g)	385.7 ± 13	266 ± 48
Total fibre (g)	34.8 ± 1.6	26.1 ± 1.5
b-Carotene (μg)	1432 ± 109	1238 ± 215
Vitamin C (mg)	40 ± 4	40 ± 10
Riboflavin (μg)	401 ± 24	350 ± 61
Thiamin (μg)	693 ± 42	497 ± 49
Folic acid (μg)	91 ± 5	85 ± 17
Niacin (μg)	12.5 ± 0.6	9.5 ± 0.7
Zinc (mg)	5.3 ± 0.3	3.8 ± 0.3
Copper (mg)	2.5 ± 0.2	2.0 ± 0.2
Iron (mg)	9.1 ± 0.4	6.8 ± 0.5

Figures are mean ± S.E.

Majority of micronutrients intake, viz. *b*-carotene, vitamin C, riboflavin, thiamin, folic acid, zinc, copper and iron showed significant positive correlation ($r = 0.31$–0.7) with intake of Sattvic food. However, intake of Rajasic food showed significant correlation with thiamin intake ($r = 0.47$), but not with other nutrients. Intake of Tamasic food exhibited significant correlation only with intake of zinc ($r = 0.23$) and iron ($r = 0.3$), which was lower than correlation with Sattvic food.

Correlation of total dietary fibre intake as well as cellulose intake with Sattvic food intake was significant ($r = 0.51$, $r = 0.57$, $P = 0.001$). Correlation between total fibre intake as also cellulose intake and Rajasic food intake was $r = 0.14$ and $r = 0.09$ respectively, and that of Tamasic food intake was $r = 0.17$ and $r = 0.20$ respectively, which were not statistically significant ($P > 0.1$).

Initially the study population was catagorized into four groups according to their occupation, viz. students, businessmen, service and others (housewives, retired persons). However, occupation did not turn out to be a significant factor in terms of stress and anxiety. Anxiety scores (STAI) were similar in both men (80.4 ± 10.9) and women (82.4 ± 9.8), so also patience scores (25.9 ± 6.9 in men and 27.4 ± 6.2 in women). Stress was 150 ± 7 in men and 157 ± 10 in women. Correlation between anxiety score and systolic and diastolic BP was significant (Pearson's $r = 0.241$, $P = 0.068$, $r = 0.325$, $P = 0.013$). Anxiety score was negatively correlated with plasma iron indicating low iron status as the cause for irritability ($r = -0.28$, $P = 0.031$). Association of anxiety score with SOD level was negative, but marginally statistically significant ($r = -0.18$, $P = 0.19$). Patience score exhibited weak association with plasma zinc ($r = 0.17$, $P = 0.20$) and SOD ($r = 0.164$, $P = 0.23$). Stress exhibited negative correlation with SOD ($r = -0.17$, $P = 0.194$). Considering correlation between type of food and mental status, only that between Tamasic food intake and anxiety score was statistically significant ($r = 0.37$, $P = 0.004$).

The basic principle of nutrition, as described in yoga, is to eat small quantities of high-quality food like fruits, vegetables, whole grains and nuts, which promote the life force of the body without producing toxins. Our efforts to find similarities between the ancient concept of good nutrition and modern science were to evolve micronutrients density, fat density and fibre density as qualitative and quantitative biomarkers for Sattvic food. This idea originated due to our previous findings that bakery products and sweets were found to be poor sources and green leafy vegetables and fruits were good sources of vitamin C, riboflavin, thiamin, *b*-carotene and folic acid[5]. In the present study, amongst 110 common food items, micronutrients content of majority of Sattvic food was found to be high, while that of Tamasic food was low and Rajasic food was intermediate. This indicated micronutrients quality of food expressed as micronutrient density to be a measure of the level of Sattva guna. Sattva relates to vital force

Table 5. Diet plan to increase intake of micronutrient-rich, low-fat Sattvic food

	Food to be avoided	Food to be included
Morning	Tea/coffee	Milk/fruit juice/herbal tea
	Bread/cake	Idli without sambhar but with green chutney/upma or pohe with vegetables/whole-wheat bread
	Egg/omlette	Soya milk
	Puri/kachori	Thepla/handvo
Lunch	Puri/alu paratha/rice	Chapati/roti/spinach-paratha/methi-paratha/vegetable stuffed paratha/rice with vegetables and sprouts with less spice
	Masoor, udid, brinjal	Mung, karela, tomato, sprouts curry
	Spicy curry, onion, garlic	Spinach/fenugreek/red amaranth
	Sweets	Fruits, vegetable salad (cucumber, cabbage, tomato, beetroot, raddish, spinach, fenugreek leaves), almonds, dates
Snacks	Samosa/potato wada/medu wada/missal/ dosa/uttappa/noodles/pizza	Ragi-thalipeeth/sprout-bhel, dhokla, handvo, colocassia-wadi/thepla/baked samosa/idli/dalia-soya upma/garden cress laddu/baked chat/baked karanji
Dinner	Pav-bhaji/kacchi-dabeli/puri/biryani	Roti made of whole wheat, bajra or ragi/unpolished rice/mix-sprouts khichadi/mung khichadi
	Chicken curry/mutton/fish	Vegetable soup/sprouts and leafy vegetable salad
	Ice cream/Srikhand/gulab jamun/sweets	Milk/fruit-salad/milkshake/garden cress kheer

which is linked to levels of consciousness other than the physical body. Micronutrients unlike macronutrients are not sources of energy to the physical body, but have an overall effect on vitality.

Low-fat diet is considered as good by modern health researchers, which is also reflected in yogic classification of good food with the exception of ghee, the high fat food considered as Sattvic. Perhaps further profiling the fat content into polyunsaturated, monounsaturated, saturated fatty acids as also w-3 and w-6 may rectify the misclassification. Further efforts of such kind may be necessary to explore differences between the two concepts.

As majority of Sattvic food is the main course of our diet, such as cereals, legumes and vegetables, intake of Sattvic food was highest amongst the study population. However, all Sattvic food items were not equally rich in micronutrients. Therefore, micronutrients intake was below RDA in more than 50% of adults. This is in agreement with the reported studies on micronutrient deficiencies[13,14]. Nevertheless, the present results suggest that all the Sattvic food items may not have the same level of Sattva and micronutrient density can be used as a measure of its degree/extent.

Diet has an intimate connection with the mind, because the mind is formed from the subtlest portion of the essence of food. No doubt, food has certain effects upon the eater. Generally, an eater, to some extent, is conditioned by the type of diet he eats[15]. Traditional Indian belief suggests an association between food consumed and thoughts and moods expressed[16]. Absorbed vibrations of food also produce psychological changes. Food can stimulate negative or gross and lethargic states like anger, lust, irritability and depression, as well as positive emotions like concentration, calmness and peaceful. Therefore, the type of food consumed will indirectly influence the vibratory state of the mind and body[17]. Our results also support these views, wherein Tamasic food does have negative association with mental health of adults, i.e. increases the anxiety levels.

Recently, impatience has been the spotlight of medical research on heart disease. Research has revealed that people with high levels of hostility and impatience in young adulthood are likely to develop high blood pressure later in life. Prevalence of cardiovascular disorders is increasing and the age of onset is decreasing. Diet plans/ alternative menus are given in Table 5 to facilitate changes towards healthy nutrition. These dietary changes substitute Sattvic food for Tamasic and Rajasic food, which is also rich in micronutrients and has low fat contents.

Finally, correlation coefficient shows association of diet and mental state. Further studies are needed to understand in-depth how diet and Prakrithi can influence each other.

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Transferability of STS markers for studying genetic diversity within the genus *Cenchrus* (Poaceae)

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Characterization of major tropical grasses is often difficult because of few discriminant morphological traits that exist due to apomictic nature of the crop. Furthermore, few molecular markers are publicly accessible. In this communication we have analysed eight prominent species of genus *Cenchrus* using isozyme markers and also the transferability of sequence tagged site (STS) markers of *Stylosanthes*, a tropical fodder legume in five species of *Cenchrus*. Of the 11 STS markers developed on the basis of cDNA sequences of functional genes, ten have generated scorable bands, whereas only four have reacted among the six STS developed based on sequences of the clones of *Pst*I library of *Stylosanthes*. Totally 195 bands were scored, of which 83% was polymorphic. Of the total 25 enzyme-coding loci generated from nine enzyme systems, 18 were polymorphic yielding 75 alleles. STS and isozyme markers separated the annual from the perennial species. However, *C. myosuroides* being perennial clustered with the annual species, possibly a bridging species among two growth habits. Results possibly suggest the use of trans genus STS markers in the analysis of polymorphism preferably at species level.

Keywords: *Cenchrus*, genetic diversity, isozyme, marker transferability, STS markers.

THE grass genus *Cenchrus* is distributed throughout the tropics. Of the 22 species recognized by Clayton and Renvoize[1], *C. cilirais* L., *C. setigerus* Vahl. and *C. pennisetiformis* Hochst and Steud. ex Steud. have been used as sown pasture with the first being by far the most prominent component of a major Indian grass cover, *Dichanthium–Cenchrus–Lasiurus*[2]. Like other tropical grasses, *Cenchrus* is also apomictic in nature and hence characterization of accessions and varieties is often difficult due to lack of reliable and distinguishable morphological traits. The situation becomes more complicated when no publicly accessible molecular markers are available. At present, using 11 agronomic attributes, 322 accessions of *C. ciliaris* and *C. setigerus* have been grouped in six categories largely on the basis of rhizome development, plant maturity and yield[3]. Nevertheless, in recent past we have genetically assessed eight species of *Cenchrus* using RAPD markers[4]. However, repeatability of such markers is always questionable. In the present communication these species were further characterized using isozyme markers. However, these markers are of limited utility relative to the number of accessions available in the IGFRI gene bank and also in maximizing the potential of sexuality observed in few accessions of *Cenchrus* species. Other presently available molecular markers (RFLP and AFLP) do not seem convenient for routine description of varieties. However, microsatellites are likely the most interesting markers, but their development is expensive and no sequences are publicly available except the possibility to use EST-based SSR markers of the related members from the grass family[5,6].

Sequence tagged site (STS) markers have been developed and used in genetic relationship and progenitor analysis in *Stylosanthes*, a tropical fodder legume[7–9]. Low levels of genome specificity of such markers have been reported in *Stylosanthes*[10]. Since tropical fodder grasses have been less intensively studied than other members of the family Poaceae and limited DNA sequences are available in the databases, transferability of STS markers developed largely on the basis of functional gene sequences was attempted to genetically analyse the tropical grasses. STS markers

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