

IMPROVEMENT IN NUTRITIONAL AND THERAPEUTIC PROPERTIES OF DAILY MEAL ITEMS THROUGH ADDITION OF OYSTER MUSHROOM

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ABSTRACT

Mushroom is the choicest food of nutritionists because of its hypolipidemic, hypocholesterolemic, hypoglycaemic, antitumor properties. Keeping in view unique chemical composition of mushroom, it was incorporated in daily food items. Fresh as well as dry mushrooms were incorporated at 50 per cent and 10 per cent level, respectively. Ingredients, their proportion and procedure of each control and experimental food items were standardized and the items were studied for their acceptance on a nine point Hedonic Scale by a panel of ten judges on a three consecutive days. Nutritive value was calculated and therapeutic use was reviewed. The study showed that mushroom is a suitable food for incorporation in breakfast, lunch, dinner and snacks food items. It can be used in sweet as well as salty and spicy foods. All the mushroom added foods were acceptable. Addition of mushrooms improves the nutritional quality and therapeutic properties as well.

Keywords: oyster mushroom, therapeutic foods, daily meals

INTRODUCTION

A large segment of our population requires attention and assistance to formulate health promoting recipes and diets, which are region and culture specific. Number of attempt have been made to develop nutritious recipes, especially out of Protein Concentrates like fish, leaf, milk, whey milk, soy, etc [1-6]. Still planners and nutritionist are thinking about the alternate source of protein in India because traditional sources of protein foods have not been keeping pace with the population growth. Next to protein, our diets are grossly deficient in micronutrients. Therefore, protein and micronutrients fortification is an important area of interest. For this purpose nutritionists are looking for ingredients of value addition especially, which impart specific nutritional properties. Mushrooms have been recognised as the alternate source of protein since they contain 25-35 per cent protein (dry weight basis) which is quite higher than vegetable and animal sources and the quality of protein is nearly as good as animal protein because of presence of all essential amino acids [7-8]. Mushrooms are good source of B vitamins i.e. thiamine, riboflavin and niacin. They are good source of potassium, phosphorus, magnesium and contain low but available form of iron.

Keeping in view the nutritional properties of oyster mushrooms, and increasing awareness for nutrition, health and quality of food consciousness, and because the demand of dietetic or therapeutic foods are increasing for the prevention and management of disease, mushroom was substituted with suitable ingredient of traditional Indian daily meal recipes in order to get optimal acceptability. Care was taken to maintain the original nutritional composition of mushrooms while formulating of mushroom recipes.

MATERIALS AND METHODS

Series of experiments were carried out for the development of food products. Developed products out of mushroom were then compared with the control (traditional) ones to find out the difference in the sensory and nutritional characters of experimental food products.

Selection of daily meal items and their standardization

From the Indian cuisine, twelve lunch and twelve breakfast and snacks items were considered. Fresh as well as dry oyster mushroom (*Pleurotus sajor caju*) was used in the food preparations as shown in Table 1A and 1B. In the experimental products fresh (50 g) and dry mushroom powder (10 g) was incorporated since this level was found acceptable in earlier studies [9-11]. The proportion of other ingredients and procedure of food preparations selected was standardized to get uniform product.

Sensory evaluation of standardized daily meal items

Human sensory perception has been the only basis of assessment of the product quality. Therefore, after recipe standardization and process standardization, the sensory attributes of the standardise food were studied using a score card of nine point Hedonic Scale with scale ranging from like-extremely to dislike-extremely [12]. The scores were allotted in ascending order that the start from like extremely (1) and end to dislike extremely. Necessary characters of individual recipe were included in the score card. All the 24 recipes, control (traditional) and experimental were prepared for a three consecutive days and subjected to sensory evaluation. Then overall acceptability mean score was calculated by considering the scores of sensory attributes evaluated (appearance, texture, taste, etc.) along with the standard deviation. Further statistical test (*t*-test) was not applied because visually, there was very minor difference in the mean scores of control and experimental preparations and the result was on the acceptable or favourable side of the scale.

Nutritional contribution of daily meal items

Nutritive values of food ingredients were calculated with the help of food value Table [13]. Since the nutritive value of oyster mushroom is not given in food tables, other sources were use [8, 14]. The available values of macronutrients (protein, fat, carbohydrate), micronutrients thiamine, riboflavin and niacin minerals (potassium, phosphorous, magnesium, sodium, calcium and iron) and essential amino acids (leucine, isoleucine, lysine, tryptophan, methionine, valine and phenylalanine) were taken for the study.

RESULT AND DISCUSSION

Sensory evaluation of daily meal items

Sensory perception assessment of preparations under study was done in quantitative terms by rating of a panel of judges with the use of Hedonic Scale. The results obtained are given in Table 1A and 1B.

Table 1A. Mean scores of overall acceptability of main meal food items

Sr. No.	Food Items		Control Food M±S.D.	Experimental Food M±S.D.	Remark
	English Name	Traditional Name			
1.	Indian Wheat Bread	<i>Phulka</i>	2.0(±0.03)	2.3(±0.09)	Like very much
2.	Indian Wheat Bread	<i>Chapati</i>	2.2(±0.02)	2.4(±0.08)	Like very much
3.	Indian Mix Grain and Vegetable Bread	<i>Missi Roti</i>	1.9(±0.04)	2.4(±0.02)	Like very much
4.	Indian Mix Grain Preserved Bread	<i>Khakara</i>	2.5(±0.04)	2.8(±0.03)	Like very much to like moderately
5.	Indian Pearl Millet Bread	<i>Bajara Roti</i>	3.3(±0.08)	2.8(±0.07)	Like moderately
6.	Indian Sorghum millet Bread	<i>Jawar Roti</i>	3.0(±0.08)	3.3(±0.08)	Like moderately
7.	Indian Maize Bread	<i>Makai Roti</i>	3.6(±0.08)	4.0(±0.08)	Like slightly
8.	Tomato Soup	<i>Sar/ Kadhi</i>	2.1(±0.07)	2.0(±0.08)	Like very much
9.	Green Salad	<i>Koshimbir/ Kachumbar</i>	2.0(±0.02)	2.1(±0.01)	Like very much
10.	Curd with Vegetables	<i>Raita</i>	2.4(±0.06)	2.2(±0.09)	like very much
11.	Capsicum fry	<i>Shimla Mirch Subji</i>	1.5(±0.02)	1.2(±0.07)	Like extremely
12.	Ladies Finger fry	<i>Bhendi Sabji</i>	1.2(±0.07)	1.0(±0.09)	Like extremely

Table 1B. Mean scores of overall acceptability of breakfast and snacks food items

Sr. No.	Food Items		Control Food M ± S.D.	Experimental Food M ± S.D.	Remark
	English Name	Traditional Name			
1.	Wheat broken porridge	<i>Suji Upma</i>	2.1 (±0.07)	2.3 (±0.09)	Like very much
2.	Rice pan cake (flat round)	<i>Uttappa</i>	1.5 (±0.06)	1.2 (±0.08)	Like extremely
3.	Rice pan cake (ball shape)	<i>Appe</i>	1.3 (±0.07)	1.1 (±0.07)	Like extremely
4.	Tomato Omlete	<i>Chilla</i>	2.0 (±0.04)	1.8 (±0.06)	Like very much
5.	Sandwich	<i>Sandwich</i>	2.8 (±0.03)	2.5 (±0.02)	Like very much to like moderate range
6.	Indian Pasta with vegetables	<i>Sevai Upama</i>	1.9 (±0.04)	2.0 (±0.03)	Like very much
7.	Wheat Gruel	<i>Ambil/Pej</i>	2.8 (±0.04)	2.4 (±0.03)	Like very much to like moderate range
8.	Vegetable pan cakes	Cutlet	1.2 (±0.07)	1.0 (±0.04)	Like very much
9.	Indian Pasta dessert	<i>Sewai Kheer</i>	2.3 (±0.01)	2.7 (±0.07)	Like very much to like moderate range
10.	Mix grain ready to eat flour	<i>Sattu</i>	2.7 (±0.03)	2.7 (±0.07)	like moderate
11.	Wheat biscuit	Biscuit	2.1 (±0.04)	2.4 (±0.04)	Like very much
12.	Puffed amaranth seeds dessert	<i>Rajgeera Chikki</i>	2.3 (±0.07)	2.0 (±0.06)	Like very much

Table 1A and 1B reveal the mean scores of overall acceptability of control and mushroom incorporated experimental daily meal items. The scores of control and experimental preparations range between 1 to 4 indicating that all the preparations are on the positive side of the scale (like extremely to like slightly). The reason behind getting the acceptability was that the daily meal items were familiar ones and there was little variation in the organoleptic attributes in control and experimental preparations.

Table 1A indicates that experimental food like, *bhindi* fry and capsicum fry were liked extremely. Whereas, tomato soup, green salad, curd with vegetables and Indian mix grain vegetable bread, wheat breads were liked very much by the judges. Indian preserve bread, Indian sorghum bread and Indian pearl millet breads fall in liked moderately and Indian maize bread in like slightly category. Mean scores of breakfast and snacks food items indicated in Table 1B ranges between liked moderately and liked extremely category. This shows that all the experimental daily meal items are acceptable. Rice pan cake (*Uttapa* and *appe*) were liked extremely by the judges followed by broken wheat with vegetables, tomato omlet, vegetable pan cake, Indian pasta dessert, *Amaranthus* dessert and wheat biscuit. Ready to eat flour (*Sattu*), gruel (*ambil*), sandwich were rated in liked moderately category by the judges. It was found that mushrooms are best suited to the recipes which require less time for cooking e.g. pan cakes. Evaluation of sensory attributes shows that addition of mushroom does not have much effect on acceptability of food preparations. Similar results were found by the investigator in previous studies [9-11]. Moreover, inclusion of mushroom gives variety to the diet.

Nutritional composition of daily meal items

Nutritional composition of food is an important criterion in determining quality of the product. The composition depends on the ingredients used in the preparations. In this study most of the food preparations were made out of cereals and mushroom was incorporated in them.

Macronutrient composition of daily meal items: Macronutrient composition is a recognized system of the assessment of the nutritional value of food items. The calculated protein, carbohydrate and fat values of food preparations under study are given along with fibre, energy values in Table 2A and 2B. The values presented are derived out of 100 g of total ingredients. Substitution of 10 g of mushroom powder provides 2.66 g protein, 5.07 g carbohydrates, 0.2 g fat, 1.33 g fibre. Ten gram dry mushrooms were obtained from 100 g fresh mushroom (as they contain 90% moisture). In some preparation 50 g fresh mushrooms were replaced by main ingredient. About 50 g fresh mushrooms provide half part of the protein, fat, carbohydrate, fibre derived from 10 g of dry mushroom. Substitution of mushroom changes the macro and micro nutrient composition of recipes as shown in Table 2A and 2B.

Table 2A. Macronutrient in daily meal items with addition of 10g dry mushroom

S.No.	Meal Item	Sample	Protein(g)	Fat(g)	Carbohydrates(g)	Fibre(g)
1.& 2.	Indian Wheat Bread	C	12.10	01.70	69.40	1.90
		E	13.46(+1.36)*	01.70(0.0)	67.47(-1.93)	3.03(+1.13)
3.	Indian Mix Grain and Vegetable Bread	C	10.44	06.85	49.10	2.53
		E	11.89(+1.45)	06.70(-0.15)	47.27(-1.83)	2.97(+0.44)
4.	Indian Mix Grain Preserved Bread	C	11.39	06.97	51.90	1.76
		E	12.84(+1.45)	06.92(-0.05)	50.07(-1.83)	2.90(+1.14)
5.	Indian Pearl Millet Bread	C	11.60	05.00	67.50	1.20
		E	13.06(+1.46)	04.70(-1.36)	66.32(-1.18)	2.41(+1.21)
6.	Indian Sorghum millet Bread	C	10.40	01.90	72.60	1.44
		E	12.06(+1.66)	01.90(0.0)	70.30(-2.30)	2.77(+1.33)
7.	Indian Maize Bread	C	11.10	03.60	66.20	2.40
		E	12.34(+1.24)	03.40(-0.20)	64.67(-1.53)	3.73(+1.33)
8.	Mix grain ready to eat flour	C	09.70	00.90	78.00	0.70
		E	11.16(+1.46)	00.90(0.0)	76.07(-1.03)	1.93(+1.23)
9.	Puff Amaranth seeds Dessert	C	12.10	09.00	74.00	1.50
		E	13.16(+1.06)	08.80(-0.20)	72.00(-2.00)	3.13(+1.63)
10.	Wheat Biscuit	C	04.50	30.48	58.80	0.09
		E	05.83(+1.33)	30.36(-0.12)	54.90(-3.80)	0.57(+0.48)

C- Control, E- Experimental

*Values in parenthesis indicated the change in value over control

Tables 2A and 2B reveal that in general there is increase in protein and fibre value and decrease in carbohydrate and fat in the experimental foods. Substitution of 10 per cent dry mushroom in breads increases 1.06 to 1.66 per cent protein. In vegetable preparation (Tomato soup, green salad, curd with vegetable, capsicum fry and ladies finger fry) 50 g fresh mushroom was substituted with basic vegetable used. Addition of mushroom certainly gives variety in flavour, texture and appearance but there was very little change in the protein value. The difference in fat values of control and experimental preparation is very minute because mushrooms contain very little fat (0.2% in fresh mushroom). Dry oyster mushrooms contain 52 per cent and cereals have 67 per cent to 77 per cent carbohydrates. Cereal carbohydrates are mostly made up of starch but mushroom carbohydrates are starch free. They comprise fungus cellulose trehalose (the mushroom sugar), sugar alcohol, mannitol. Inclusion of 10 per cent dry mushroom supplies 5 per cent carbohydrates which are not nutritionally important so far as calories are concerned. Therefore, carbohydrates contributed by mushrooms give a small relief of calories to the experimental recipes. The fibre content of mushrooms is good on dry weight basis. Incorporation of mushroom even though in small amount supplies 1.3 per cent additional fibre. Remaining preparations were vegetable based in which fresh mushrooms were included. Fresh mushrooms have 1.3 per cent fibre therefore inclusion of 50 g mushroom supplied 0.65 per cent fibre. This amount is similar to the amount of fibre supplied by the vegetables (1.2%). Therefore, there is negligible difference in the values of fibre of control and experimental food items.

Table 2B. Macronutrient in daily meal items with addition of 50 g fresh mushroom

S. No.	Meal Item	Sample	Protein(g)	Fat(g)	Carbohydrates(g)	Fibre(g)
11.	Tomato Soup	C	01.40	10.58	06.60	0.61
		E	02.30(+0.9)*	10.58(0.0)	07.40(-1.03)	0.82(+0.21)
12.	Green Salad	C	01.80	01.10	05.80	1.13
		E	02.05(+0.25)	01.10(0.0)	05.20(-0.60)	1.11(-0.02)
13.	Curds with Vegetables	C	02.60	03.10	05.00	0.46
		E	03.90(+1.30)	03.04(-0.06)	03.64(-1.36)	0.24(-0.22)
14.	Capsicum Fry	C	01.90	11.18	05.88	2.32
		E	02.54(+0.64)	10.60(-0.58)	04.34(-1.54)	2.43(+0.11)
15.	Ladies Finger Fry	C	01.49	10.17	05.16	0.98
		E	01.73(+0.24)	10.17(0.0)	04.86(-0.30)	0.98(0.0)
16.	Wheat Broken Vegetable Porridge	C	10.00	11.40	50.00	5.90
		E	10.08(+0.08)	11.30(-0.10)	49.60(-0.40)	6.30(+0.40)
17.	Rice Pan Cake (Flat Round)	C	12.80	10.75	38.30	0.76
		E	13.19(+0.39)	10.70(-0.05)	36.68(-1.62)	1.06(+0.30)
18.	Rice Pan Cake (Ball Shape)	C	07.40	10.45	47.10	0.50
		E	07.79(+0.39)	10.40(-0.05)	45.40(-1.70)	0.80(+0.30)
19.	Tomato Omllet	C	13.00	13.46	37.30	1.36
		E	14.12(+1.12)	13.45(-0.05)	37.70(+0.40)	1.36(0.0)
20.	Sandwich	C	05.00	16.40	33.50	0.10
		E	06.30(+1.30)	12.50(-3.90)	31.00(-2.50)	0.76(+0.66)
21.	Indian Pasta Dessert	C	07.50	10.60	49.60	1.03
		E	06.80(-0.7)	10.54(-0.06)	44.30(-5.30)	0.70(-0.33)
22.	Wheat Gruel	C	04.30	17.80	26.90	1.40
		E	04.87(+0.57)	15.90(-1.90)	24.30(-2.60)	1.50(+0.10)
23.	Vegetables Pan Cake	C	04.60	10.33	58.00	1.93
		E	04.87(+0.27)	10.23(-0.10)	58.00(0.0)	1.03(-0.90)
24.	Indian Pasta with Vegetables	C	07.50	10.06	49.60	1.03
		E	08.20(+0.7)	10.00(-0.06)	44.30(-5.30)	0.70(-0.33)

C- Control, E- Experimental

*Values in parenthesis indicated the change in value over control

Essential amino acids content of daily food items: In general animal protein are considered superior and vegetable protein are considered inferior since it is deficient in one or the other essential amino acids. Lysine is a limiting amino acid of cereals and methionine is limiting amino acid of pulses. Therefore, vegetarian diet needs a good combination or supplementation of food to improve protein quality. As mushrooms are recognized for the essential amino acids, therefore, these are suitable food for supplementation or rather a good food for the combination with vegetable food items. In the present investigation, therefore, attempts were made to combine mushroom with other vegetable foods and essential amino acids were calculated. Calculated values are given in Table 3A and 3B. It is revealed from the Table 3A and 3B that all the values of essential amino acids of experimental food items are higher than control samples. It shows that food items 1 to 10 are rich in amino acids as dry mushroom was incorporated in them. Remaining preparation based on vegetable are low because vegetables have 90 per cent moisture. Lysine is a limiting amino acid of cereal and mushrooms are good source of it. Therefore, all the lysine values of experimental food items were more than the control samples. All these experimental items provide half to three fourth of the daily requirement of lysine of adults. Methionine, a sulphur containing amino acid also plays important role in maintaining the health of liver. This is a limiting amino acid of pulses. Incorporation of mushroom in food item shows increase in methionine in liberal amount.

Table 3A. Essential amino acids (mg) in daily meal items with addition of 10 g dry mushroom

Sr. No.	Meal Items	Sam- ple	Leucine	Isoleucine	Valine	Tryptophan	Lysine	Threonine	Phenylalanine	Methionine
1.&2.	Indian Wheat Bread	C	0775	416	529	132	321	340	529	170
		E	0873 (+98)*	463 (+45)	609 (+80)	149 (+17)	431 (+110)	431 (+91)	602 (+83)	198 (+28)
3.	Indian Mix Grain and Vegetable Bread	C	0682	395	458	107	367	335	469	140
		E	0788 (+106)	464 (+69)	538 (+80)	124 (+17)	477 (+110)	390 (+55)	542 (+73)	168 (+28)
4.	Indian Mix Grain Preserved Bread	C	0651	360	424	099	335	314	437	130
		E	0747 (+96)	429 (+69)	504 (+80)	116 (+17)	450 (+125)	369 (+55)	510 (+73)	158 (+28)
5.	Indian Pearl Millet Bread	C	1395	484	614	205	353	446	539	279
		E	1430 (+35)	546 (+62)	685 (+71)	215 (+10)	460 (+107)	526 (+80)	610 (+71)	296 (+17)
6.	Indian Sorghum millet Bread	C	1460	448	564	116	249	349	498	166
		E	1489 (+29)	513 (+65)	640 (+76)	134 (+18)	366 (+117)	439 (+90)	573 (+75)	194 (+28)
7.	Indian Maize Bread	C	1282	427	534	071	356	498	516	214
		E	1329 (+47)	494 (+64)	612 (+78)	094 (+23)	462 (+106)	573 (+75)	589 (+73)	238 (+24)
8.	Mix grain ready to eat flour	C	0599	364	393	095	145	191	393	198
		E	0697 (+98)	432 (+68)	409 (+16)	119 (+24)	253 (+108)	282 (+91)	465 (+72)	226 (+28)
9.	Puff Amaranth seeds Dessert	C	0524	378	321	100	470	336	481	157
		E	0659 (+135)	467 (+84)	430 (+119)	125 (+25)	580 (+110)	434 (+88)	586 (+105)	192 (+35)
10.	Wheat Biscuit	C	0315	171	189	048	087	117	144	072
		E	0332 (+17)	186 (+15)	213 (+24)	052 (+04)	138 (+51)	159 (+42)	174 (+30)	078 (+06)

C- Control, E- Experimental

*Values in parenthesis indicated the change in value over control

Table 3B. Essential amino acids (mg) in daily meal items with addition of 50 g fresh mushroom

Sr. No.	Meal Items	Sample	Leucine	Isoleucine	Valine	Tryptophan	Lysine	Threonine	Phenylalanine	Methionine
11.	Tomato Soup	C	110	124	098	014	070	067	074	030
		E	167(+57)*	110(-14)	123(+25)	026(+12)	117(+47)	101(+34)	123(+49)	044(+14)
12.	Green Salad	C	106	115	099	021	083	067	081	026
		E	135(+29)	126(+11)	101(+02)	024(+03)	098(+15)	093(+36)	099(+18)	035(+09)
13.	Curds with Vegetables	C	223	130	189	032	190	125	133	029
		E	363(+140)	158(+28)	221(+32)	040(+08)	230(+40)	156(+31)	177(+44)	043(+14)
14.	Capsicum Fry**	C	-	-	-	-	-	-	-	-
		E	-	-	-	-	-	-	-	-
15.	Ladies Finger Fry	C	054	034	043	007	047	032	034	018
		E	106(+52)	066(+32)	081(+38)	019(+12)	087(+40)	072(+40)	074(+40)	028(+10)
16.	Wheat Broken Vegetable Porridge	C	596	346	397	096	304	236	401	122
		E	626(+30)	360(+14)	413(+16)	098(+02)	366(+62)	252(+16)	469(+68)	132(+10)
17.	Rice Pan Cake (Flat Round)	C	949	634	596	138	737	418	598	176
		E	1030(+81)	682(+48)	648(+52)	144(+06)	779(+42)	472(+54)	642(+44)	192(+16)
18.	Rice Pan Cake (Ball Shape)	C	323	347	207	083	142	169	225	204
		E	407(+84)	393(+56)	261(+54)	090(+07)	184(+42)	402(+233)	369(+144)	220(+16)
19.	Tomato Omllet	C	968	548	527	093	733	375	602	136
		E	1006(+48)	560(+02)	557(+30)	105(+12)	783(+50)	412(+37)	644(+42)	150(+14)
20.	Sandwich	C	-	-	-	-	-	-	-	-
		E	-	-	-	-	-	-	-	-
21.	Indian Pasta Dessert	C	442	248	308	075	217	204	301	095
		E	462(+20)	252(+04)	320(+12)	123(+48)	221(+04)	224(+20)	510(+209)	105(+10)
22.	Wheat Gruel	C	415	225	287	073	182	180	283	091
		E	477(+62)	265(+40)	313(+26)	081(+08)	232(+50)	214(+34)	329(+46)	103(+12)
23.	Vegetable Pan Cake	C	189	129	135	031	095	089	108	034
		E	203(+24)	139(+10)	145(+10)	037(+06)	105(+10)	095(+06)	118(+10)	119(+85)
24.	Indian Pasta with Vegetables	C	442	248	308	075	217	204	301	095
		E	462(+20)	252(+02)	320(+12)	113(+38)	221(+04)	224(+10)	510(+209)	105(+10)

C- Control, E- Experimental

*Values in parenthesis indicated the change in value over control

** Values are not available in food table

Micronutrient content of daily meal items

In general, mushrooms are good source of many vitamins, especially those of B-complex group. Among B complex vitamins, mushrooms are especially rich in thiamine, riboflavin, niacin and biotin as well. *Pleurotus* species contain thiamine 1.16 to 4.8 mg, riboflavin 0.40 mg and niacin 46 to 109 mg. Folic acid and vitamin B₁₂ (which is absent in plant food) are present in mushrooms, although in small quantities. Like most vegetables, mushrooms are rich in potassium, followed by phosphorus, magnesium and calcium. Iron is present in appreciable amount in *Pleurotus* species. Besides, mushroom contains copper, zinc, manganese, cadmium and lead. Taking into consideration these facts, mushrooms were substituted in daily meal food preparations and change in selected micronutrient composition are shown in Table 4A and 4B.

It is revealed from the Table 4A and 4B that the most of the micronutrient values of experiment food items are higher than the traditional food items. Especially there is remarkable change in values of potassium, niacin, riboflavin and thiamine. Requirement of niacin is 6.6 mg/ 1000 Kcal. Experimental food preparations under this present study provide a good amount of niacin. Riboflavin and thiamine play important role in the several oxidation processes inside the cell and concerned with energy and protein metabolism. Indian diets are generally deficient in these vitamins. It is evident from Table 4A and 4B that all the values of thiamine and niacin of experimental food items are higher than traditional food items. The difference in values are because dry mushroom (a concentrated source of nutrient) was incorporated in 1-10 items and fresh mushroom was added in remaining experimental food items. Rest of the micronutrient values indicated in Table 4A and 4B reveal a difference which is not very significant. Addition of mushrooms does not affect much on sodium values since mushrooms are low sodium food. Mushrooms are good source of phosphorus after potassium but the change in experimental food values is not remarkable because cereals and vegetables are also good sources of phosphorus. Similar observations are seen in case of magnesium, iron and calcium. Negative difference was observed in sodium, phosphorus, iron and calcium of experimental recipes since vegetables are good source of these nutrients.

Therapeutic properties of daily meal items

Every food preparation has therapeutic properties due to presence of various nutrients. Therapeutic properties depend on the macro and micro nutrients present in food ingredients. These nutrients assist the patient to recover fast from the illness. But the recovery depends on the quantity and proportion of nutrients present in foods. Therapeutic properties of food are generally determined by feeding experiments. But initially it is necessary to find out the quantity and proportion of nutrients present in food preparations. In the present investigation presence of therapeutic properties were assessed by using food value table and their suitability was then decided. Recipes from routine diet were selected for the incorporation of mushrooms in order to get the acceptability. Care was taken to maintain the original nutritional composition of mushrooms. Mushrooms are low calorie, high protein, starch and sugar free, cholesterol free, low fat, high potassium and low sodium, good fibre, good vitamins B complex with vitamins B₁₂ and good in trace elements. Mushrooms require less time for cooking and also need low temperature for cooking. Thus prevent losses during cooking. The recipes which require less time for cooking are suitable for mushrooms. Mushrooms are in general used for garnishing purpose or just to enrich aesthetic, sensory and nutritional quality of food preparations. Above said properties of mushroom are well suited to normal as well diseased individuals. Plain wheat preparations became more nutritious after substitution of ten per cent mushroom powder. Wheat is a good source of starch (69%) and have moderate amount of protein (12%). But the quality of protein is not good because it is deficient in lysine, tryptophan, threonine and methionine as well. Besides it contains moderate amount of riboflavin, thiamine and niacin. Inclusion of mushroom made this wheat preparation better in respect of protein quality, vitamin B and minerals content, hence improves the therapeutic properties. This improved food item of lunch and dinner of Indian diet can be recommended to normal, vulnerable and in therapeutic diets. Reduction in carbohydrate and increase in fibre become good for diabetes and obesity. High potassium content in mushrooms is good for heart patient. Millets are rich in carbohydrate and moderate in protein (10-11%). *Bajara* (pearl millet) is good in mineral content especially iron. Maize is better in lysine but poor in tryptophan and methionine. *Jowar* (sorghum) is poor in tryptophan, methionine and rich in leucine, potassium, calcium and maize is deficient in calcium and iron. Addition of mushroom powder has improved the quantity and quality of protein, increased thiamine, riboflavin and niacin and potassium in good amount and phosphorus, iron in moderate amount.

Table 4A. Micronutrients (mg) in daily meal items with addition of 10 g dry mushroom

Sr. No.	Meal Item	Sample	Thiamine	Riboflavin	Niacin	Potassium	Sodium §	Phosphorus	Magnesium	Iron	Calcium
1&2.	Indian Wheat Bread	C	0.49	0.17	43.00	315	20	355	132	04.90	029
		E	0.84(+0.35)*	0.55(+0.38)	49.50(+6.50)	610(+305)	24(+04)	396(+41)	142(+10)	05.64(+0.74)	028(-01)
3.	Indian Mix Grain and Vegetable Bread	C	0.58	0.31	04.24	269	38	259	100	03.90	123
		E	0.89(+0.31)	0.64(+0.33)	14.40(+10.16)	564(+305)	42(+04)	300(+41)	109(+09)	04.74(+0.84)	131(+08)
4.	Indian Mix Grain Preserved Bread	C	0.60	0.27	04.19	304	28	286	118	03.98	083
		E	0.95(+0.35)	0.65(+0.38)	14.59(+10.40)	599(+295)	31(+03)	327(+41)	127(+09)	04.82(+0.84)	081(-02)
5.	Indian Pearl Millet Bread	C	0.33	0.25	02.30	307	11	296	137	08.00	042
		E	0.95(+0.62)	0.65(+0.40)	14.59(+12.29)	599(+292)	31(+20)	327(+31)	127(-10)	04.82(-3.18)	081(+39)
6.	Indian Sorghum millet Bread	C	0.37	0.13	03.10	131	07	222	171	04.10	025
		E	0.73(+0.36)	0.51(+0.38)	18.60(+15.50)	444(+313)	13(+06)	275(+52)	176(+06)	04.95(+0.85)	025(00)
7.	Indian Maize Bread	C	0.42	0.10	01.80	286	16	348	139	02.30	010
		E	0.78(+0.36)	0.49(+0.39)	12.42(+10.62)	583(+297)	20(+04)	389(+41)	147(+08)	03.31(+1.01)	011(+01)
8.	Mix grain ready to eat flour	C	0.18	0.07	02.60	221	15	182	046	02.80	040
		E	0.53(+0.35)	0.45(+0.38)	12.90(+10.30)	533(+312)	19(+04)	228(+46)	084(+38)	03.50(+0.70)	038(-02)
9.	Puff Amaranth seeds Dessert	C	-	-	-	-	-	485	-	10.60	174
		E	-	-	-	-	-	505(+20)	-	11.30(+0.70)	254(+80)
10.	Wheat Biscuit	C	0.70	-	0090	045	04	054	027	0090	009
		E	0.80(+0.10)	0.20(+0.20)	06.10(+5.20)	166(+121)	06(+02)	080(+26)	032(+05)	00.70(+0.20)	007(-02)

C- Control, E- Experimental

§ Salt sodium is not included

- Values are not available

*Values in parenthesis indicated the change in value over control

Table 4B. Micronutrients (mg) in daily meal items with addition of 50 g fresh mushroom

Sr. No.	Meal Item	Sample	Thiamine	Riboflavin	Niacin	Potassium	Sodium §	Phosphorus	Magnesium	Iron	Calcium
11.	Tomato Soup	C E	0.16 0.30(+0.14)*	0.05 0.22(+0.16)	0.041 05.59(+5.18)	117 206(+89)	017 013(-04)	020 048(+28)	003 014(+11)	054 0.89(+0.35)	085 011(-24)
12.	Green Salad	C E	0.07 0.23(+0.16)	0.22 0.30(+0.12)	0.066 05.73(+5.07)	093 204(+111)	086 019(-17)	180 118(-62)	015 018(+03)	202 1.62(+0.40)	142 083(-59)
13.	Curds with Vegetables	C E	0.01 0.29(+0.28)	0.12 0.44(+0.32)	0.027 02.89(+2.62)	130 284(+154)	085 028(-07)	229 447(+218)	005 009(+04)	045 0.63(+0.18)	136 154(+18)
14.	Capsicum Fry	C E	0.43 0.48(+0.05)	0.05 0.41(+0.36)	0.058 05.93(+5.35)	048 354(+306)	010 005(-05)	032 078(+46)	002 034(+32)	108 1.76(+0.68)	049 119(+30)
15.	Ladies Finger Fry	C E	0.06 0.22(+0.16)	0.06 0.26(+0.20)	0.049 01.40(+0.91)	092 197(+105)	006 006(00)	044 094(+50)	040 044(+04)	032 0.76(+0.44)	054 056(+02)
16.	Broken Wheat Vegetable Pongide	C E	0.34 0.54(+0.20)	0.13 0.33(+0.20)	0.328 07.68(+4.40)	722 821(+99)	025 024(-01)	294 297(+03)	100 102(+02)	430 4.69(+0.39)	089 092(+03)
17.	Rice Pan Cake (Flat Round)	C E	0.19 0.39(+0.20)	0.10 0.30(+0.20)	0.140 05.00(+3.60)	433 532(+99)	020 018(-02)	198 210(+12)	078 080(+02)	212 2.44(+0.32)	134 132(-02)
18.	Rice Pan Cake (Ball Shape)	C E	0.08 0.28(+0.20)	0.06 0.26(+0.20)	0.130 04.50(+3.20)	152 253(+101)	007 005(-02)	097 116(+19)	092 095(+03)	127 1.52(+0.25)	042 045(+03)
19.	Tomato Omelet	C E	0.31 0.45(+0.14)	0.12 0.28(+0.16)	0.169 04.30(+2.61)	462 613(+171)	047 045(-02)	211 325(+114)	119 129(+10)	352 3.82(+0.30)	088 089(+01)
20.	Sandwich	C E	0.04 0.24(+0.20)	- -	0.040 05.80(+5.40)	- -	- -	- -	- -	070 1.00(+0.20)	007 008(+01)
21.	Indian Pasta Dessert	C E	0.03 0.83(+0.80)	0.14 0.90(+0.76)	0.026 20.17(+19.91)	105 531(+426)	055 046(-09)	085 203(+118)	006 036(+30)	022 2.39(+2.17)	091 092(+01)
22.	Wheat Gnel	C E	1.86 2.00(+0.14)	0.04 0.24(+0.20)	0.115 07.45(+6.30)	088 223(+135)	047 042(-05)	143 194(+51)	031 033(+02)	322 3.50(+0.32)	057 035(-02)
23.	Vegetable Pan Cake	C E	0.20 0.41(+0.21)	0.02 0.20(+0.18)	0.088 05.10(+4.12)	123 208(+85)	024 021(-03)	129 149(+20)	024 026(+02)	083 1.05(+0.22)	026 028(+02)
24.	Indian Pasta with Vegetables	C E	1.03 1.13(+0.10)	0.02 0.20(+0.18)	0.113 05.68(+4.55)	110 222(+112)	149 147(-02)	039 049(+10)	044 048(+04)	206 2.71(+0.65)	032 029(-03)

C- Control, E- Experimental

§ Salt sodium is not included

- Values are not available

* Values in parenthesis indicated the change in value over control

Therefore, wheat breads, millet breads can be recommended in daily diet of normal as well as diseased individual. Mix grain and vegetable bread (*Missi roti*) and preserved bread (*khakara*) are basically considered nutritious as these recipes are combination of cereal, pulse and green. Addition of mushroom powder has improved especially the lysine, niacin with good amount of thiamine and riboflavin and potassium content. Therefore, these foods can be recommended as supplementary food for vulnerable and in low carbohydrate diet like obesity, diabetes and heart disease. While preparing these recipes, table salt can be avoided in low sodium diet. Tomato mushroom soup and green mushroom salad are recommended in low calorie and low sodium diet. Increase of essential amino acid has improved the quality of whatever meagre amount of protein is supplied. These contain good amount of niacin, riboflavin and thiamine. Mushroom capsicum fry and mushroom ladyfinger fry are novel vegetable preparations which can be added in the low sodium diet. Breakfast and snacks items (mushroom *dalia*, mushroom *uttapa*, mushroom *appe*, mushroom *sattu* and mushroom *rajgeera chikki*) are high protein foods, hence good for vulnerable. Mix grain ready to eat flour (mushroom *sattu*) and Indian pasta dessert (mushroom *kheer*) are better in fibre therefore good for high fibre diet. All the mushroom recipes are better in niacin, riboflavin, thiamine content hence suitable for all the therapeutic diets. In general the mushroom recipes are good in protein, low fat (saturated fat), moderate carbohydrates, low calorie, high thiamine, riboflavin and niacin, high potassium, moderate fibre, hence are suited in most of the therapeutic diets. In general due to the unique chemical composition, mushrooms are suitable in therapeutic diets. Low calorie, sugar free mushroom are delight of the diabetes. Its high potassium, low sodium ratio, few calories and good fat (rich in linoleic and free in cholesterol), mushroom is the choice of the dietician for atherosclerosis, hypertension and obesity. Soft fibre content makes them suitable for constipating individual as well. Moreover, it is well known for their precious medicinal factors i.e. antifungal, antibacterial, antiprotozoal, antiviral, anti-hypertension, anti-tumor, hypo-lipidemic, hypocholestermic etc. Their most significant active principle, immuno stimulating polysaccharides strengthen the immunity. *Pleurotus sajor caju* has hypotensive action which reduce the rate of nephron deterioration which may extend life span of chronic renal failure patents [15].

CONCLUSION

Keeping in view the improved sensory properties of developed mushroom daily meal items, they are suitable for incorporation in diet of all categories of people. The fresh and dry mushroom/ mushroom powder can be incorporated in a food item to enhance its nutritive and therapeutic value without affecting its acceptability.

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