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CONTRIBUTION OF SUMMER VEGETABLE PREPARATIONS IN PROVIDING ASCORBIC ACID, β-CAROTENE, CALCIUM AND IRON TO URBAN AND RURAL HOUSEHOLDS

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ABSTRACT

The study determined the contribution of available summer vegetables consumed mostly as traditional vegetable preparations to the supply of essential nutrients to the consumers. Sixty households, thirty each from urban and rural areas of Ludhiana district, Punjab, India were selected to obtain information regarding vegetable consumption. Most frequently consumed eleven vegetables preparations were prepared in the laboratory as per the information provided by the surveyed households and analysed for ascorbic acid, β-carotene, calcium and iron. Average daily per capita consumption of vegetables was 417 and 480g by urban and rural households, respectively. Vegetable preparations provided 80 and 76% of the total daily vegetable intake for urban and rural households, respectively. Ascorbic acid, β-carotene, calcium and iron content in eleven most frequently consumed cooked vegetable preparations namely potato beans, potato brinjal, brinjal *bhartha*, potato capsicum, okra, bottle gourd, ridge gourd, summer squash, pumpkin, colocasia and bitter gourd ranged between 0.3 to 62 mg, 0.8 to 98.7 µg, 10.6 to 181.87 mg and 0.09 to 0.81 mg/100g, respectively on fresh weight basis. The vegetable preparations provided 125.3, 2.1, 17.3 and 4.2% of ascorbic acid, β-carotene, calcium and iron to the urban households, respectively. The corresponding percentages for rural households were 138.5, 2.3, 19.1 and 4.7%. The summer vegetable preparations were significant source of ascorbic acid for urban and rural Punjabi households meeting more than 100% of the recommended level, however these vegetable preparations were very small contributors to the daily requirements of nutrients such as β-carotene, calcium and iron during summer.

Keywords: Vegetable consumption, vegetable preparations, ascorbic acid, β-carotene, calcium, iron.

INTRODUCTION

Vegetables supply many nutrients besides providing variety to the diet. They make the food alterative by their colour, texture and flavour. Though Indian population is mostly vegetarian, the intake of vegetables has been too low in daily diet. People do not eat vegetables or eat less in quantity because they are expensive, need more preparation time or due to ignorance of the importance of vegetables (Srilakshmi 2010**)**. Properly planned and cooked vegetarian diets are healthy, nutritionally adequate and provide health benefits in reducing the risk of several degenerative diseases. The World Health Organization (2002) estimates that low fruit and vegetable intake contributes to approximately 2.7 million deaths a year from chronic diseases and causes about 31% of ischemic heart diseases and 11 % of stroke worldwide. The sixth main risk factor for mortality in the world is the low fruit and vegetable intake. Fruit and vegetable (FV) consumption plays a protective role in the onset of these chronic diseases (Van Duyn and Pivonka 2000), and a low fruit and vegetable intake is one of the leading risk factors for death from cancer worldwide (Danaei *et al* 2005).

Most vegetables are commonly cooked before being consumed. In general, vegetables are prepared at home on the basis of convenience and taste preference rather than retention of nutrition and health-promoting compounds (Masrizal *et al* 1997). The fresh vegetable produce is abundant during summer season in Punjab. Though fresh vegetables are important source of vitamins and minerals in Punjabi diet but the availability of the nutrients from the vegetables gets altered at varying degree when they are subjected to different traditional processing method that are in vogue at household level.

Punjab climate is suitable for wide array of nutritious vegetables during winter, however, summer season; though comparatively longer have lesser green vegetables availability resulting in lesser vitamin and mineral consumption during the lean period leading to poor nutritional status of the consumers. The study determined the contribution of available summer vegetables consumed mostly as traditional vegetable preparations to the supply of essential nutrients to the consumers.

MATERIALS AND METHODS

SELECTION OF HOUSEHOLDS

Sixty middle-income households, thirty each from urban and rural areas of Ludhiana district, Punjab, India were selected randomly to collect the information related to vegetable consumption during summer season. Urban households included the employees of Punjab Agricultural University (PAU), Ludhiana with monthly family income ranging between Rs. 30,000 to 50,000 whereas, rural households with landholding size of 5-10 acres were selected from village Mullanpur, District, Ludhiana. The information was supplied by the women engaged in cooking process of the households.

DEVELOPMENT OF QUESTIONNAIRE

A questionnaire was developed to collect the information regarding the types of cooked vegetable dishes, vegetable consumption pattern and cooking procedures. Data was collected during the months of May and June, 2013 when summer vegetables were available.

DIETARY SURVEY

24 hour recall method for three consecutive days was used to assess the total per capita vegetable intake by the households. The information about edible portion of commonly consumed vegetables was obtained from the surveyed households. The percentage of each vegetable that was edible was calculated in the laboratory by weighing both the whole vegetable and the edible portion as reported by the households and dividing the former weight by the latter.

VEGETABLE PREPARATIONS AND CHEMICAL ANALYSIS

Most commonly consumed eleven vegetables preparations namely potato beans, potato brinjal, brinjal *bhartha*, potato capsicum, okra, bottle gourd, ridge gourd, summer squash, pumpkin, colocasia and bitter gourd were cooked in the laboratory for chemical analysis. The corresponding raw samples of each vegetable preparation were also prepared by mixing all the ingredients in the same proportions as in case of cooked samples. The samples were prepared thrice. Cooked and raw samples were weighed, homogenized. Ascorbic acid and β-carotene contents were determined as percentages of fresh weight. Ascorbic acid was estimated using the methods given by AOVC (Association of Vitamin Chemists, 1996) and β-carotene by column chromatography (Rao, 1967). Calcium and iron were estimated in dried samples using atomic absorption spectrophotometer after wet digestion. The mean value and standard deviation for each sample were calculated and differences were tested for significance by Student's t-test. For adult Indian men and women, the recommended dietary allowance of ascorbic acid, β-carotene, calcium and iron is 40mg, 4800µg, 600mg and 21mg , respectively (ICMR, 2010). The contribution of vegetable preparations to daily nutrient intake against recommended dietary allowances (RDA) of ICMR (2010) were calculated from survey observations and chemical analysis.

RESULTS AND DISCUSSION

VEGETABLE CONSUMPTION

The daily per capita consumption of leafy vegetables through vegetable preparations by urban and rural households ranged between 33.3 to 100 and 16.7 to 208g, respectively. The corresponding mean values were 51.7 and 59.7 g. The consumption of green leafy vegetables was lower in both urban and rural households. This might be due to summer season when supply of green leafy vegetables was not sufficient. Average daily per capita consumption of roots and tubers through vegetable preparations was 68.6 and 74.5 g, by urban and rural households, respectively. The corresponding values for other vegetables were 213 and 231g. Contribution of vegetable preparations to total vegetable consumption of urban and rural households was 333.3 and 365g. Contribution of vegetable preparations to total daily vegetable consumption of urban and rural households was 80 and 76%, respectively. Average vegetable consumption through other preparations was 34.1 and 38.8g /day by urban and rural households. The percent contribution to total vegetable intake being 8.2 and 8.1%. The daily per capita consumption of vegetable used as a salad i.e. onion, tomato, cucumber, radish ranged from 25 to 83.3 and 31.2 to 140 g /day by urban and rural households with the average value of 49.2 and 76 g/ day, respectively. The salads contributed 12 and 15.8% of vegetables to total per capita vegetable consumption of urban and rural households (Table 1 and Fig 1). The results revealed that the maximum consumption of vegetables was through vegetable preparations. No significant difference was found in the consumption of vegetables by urban and rural households. Gupta and Bains (2006) reported an average daily per daily capita consumption of green leafy vegetable during winters as 85.6 g among farm families belonging to three agroclimatic zones of Punjab. Shruti (2005) reported the average daily consumption of roots and tubers through vegetable preparations by urban and rural families was 133.6 and 96.7g, respectively. The corresponding values for other vegetables were 79.3 and 38.4g. Anamika (2013) reported low consumption of green leafy vegetables by farm women. The consumption of roots and tubers and other vegetables was inadequate i.e. 62.7g and 49.0g compared to suggested value of 100g among farm women.

Table 1: Daily per capita consumption (g) of vegetables by urban and rural households

Vegetables	Urban (n=30)		Rural (n=30)	
	Range	Mean± SD	Range	Mean± SD
Vegetable preparations				
Leafy vegetables	33.3- 100	51.7±17.1	16.7-208	59.7±33

Roots and tubers	9.17-310	68.6±39.6	14.7-167	74.5±38.5
Other Vegetables	125-444	213±17.3	55.5-500	231±137
Total		**333.3**		**365**
Other preparations*	11 – 66.7	34.1±13.3	16.7-71	38.8±12.5
Salad	25 -75	49.6±15	31.2-140	76.0±27.6
Total		**417**		**480**

*Other preparations include cooked dishes based on cereals and legumes with small amounts of vegetables mainly onion, tomato, ginger and garlic.

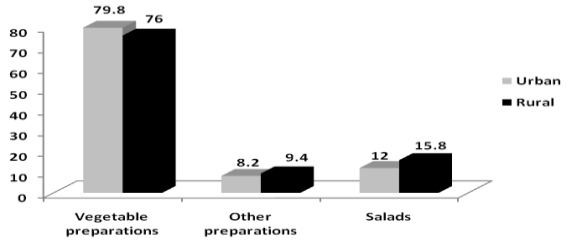

Figure 1. Percent contribution of vegetable preparations, other preparations and salads to total vegetable intake tourban and rural households

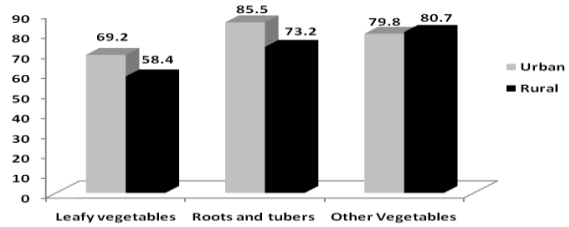

Figure 2. Percent edible portion of vegetables consumed by urban and rural households.

ASSESSMENT OF EDIBLE PORTION

Edible portion of the vegetables used for cooking is presented in Fig. 2. The assessment of edible portion of vegetables was made on the basis of information supplied by the surveyed urban and rural households. In case of leafy vegetables, the percent edible portion ranged between 42.5 to 93.7 and 51.2 to 94.2% with mean value of 69.2 and 58.4 % as reported by urban and rural households, respectively. Wide variations were observed in the edible portion of leafy vegetables, minimum value was reported in spinach followed by amaranth and maximum value was observed in mint leaves. In spinach and amaranth, both urban and rural households use only leaves and stalks were discarded. The percent edible portion of roots and tubers ranged between 62.5 to 96.5 and 63.3 to 97.2% in urban and rural households with mean value of 85.5 and 73.2 %, respectively. The edible portion of other vegetables ranged between 53.4 to 97.2 % in both urban and rural households with mean value of 81.4 and 82.2%, respectively. On an average, urban and rural households reported 78.2 and 70.8% portion of the vegetables as edible. Result are close to the observations Shruti (2005) who reported 78.5 and 79.3% portion of the vegetables as edible for urban and rural families during winter season.

NUTRITIONAL ANALYSIS

Ascorbic content in the raw vegetables and vegetable preparations ranged from 0.5 to 88.6 and 0.3 to 62 mg /100 g with mean values of 26.5 and 18.5 mg / 100 g, respectively (Table 2). The maximum value in cooked vegetable preparations was in bitter gourd followed by potato beans and minimum value was in colocasia. There was a wide variation in the percent loss of ascorbic acid i. e. 18 to 46 in the analyzed vegetable preparations. The variation might be due to different cooking procedures, cooking time, preparations method, followed for the preparation of recipes based on information provided by urban and rural households. The maximum loss was observed in brinjal *bhartha*, followed by summer squash and minimum loss was in potato brinjal recipe. The average loss of ascorbic acid during cooking was 33 mg/100g (Table 2). Maximum loss in brinjal *bhartha* was due to direct roasting of brinjal on flame and open pan cooking. Shruti (2005) reported the maximum loss of ascorbic acid in potato-cauliflower (36.4) closely followed by mustard *saag* (35.9%) and potato beans (33.3%). Somsub *et al* (2008) observed that blanching, stir frying and boiling caused a decrease in the total vitamin C with losses from 14% to 95%, the greatest loss (95%) being found in boiling bitter cucumber (*Monordica charantia* Linn). Bembem and Sadana (2012) reported that the ascorbic acid content of potatoes (17.91mg/100g) decreased significantly ($p < 0.05$) on cooking.

Table 2: Ascorbic acid and β- carotene content of raw and cooked vegetable preparations (per 100g fresh weight)

Vegetable	**Ascorbic acid (mg)**			**β- Carotene(µg)**		
Preparations	**Raw**	**Cooked**	**% Loss**	**Raw**	**Cooked**	**% Loss**
Potato beans	42.8±0.85	33.1±0.50	22.6±0.10	73.3±0.54	43.7±0.19	40±0.12
Potato brinjal	23.1±0.40	18.9±0.21	18±0.11	65.8±0.54	52.6±0.51	20±0.12
Potato capsicum	88.6±0.29	62±0.48	30±0.21	122.5±0.55	70±0.45	42.8±0.22
Brinjal *bhartha*	10±0.19	5.4±0.21	46±0.42	62.4±0.47	28.9±0.21	53.6±0.17
Okra	16.5±0.16	10.9±0.20	33.9±0.12	60±0.22	43±0.20	33.3±0.20

Bottle gourd	1.2±0.10	0.88±0.20	26.7±0.15	1.1±0.19	0.8±0.11	27.2±0.25
Ridge gourd	5.45±0.52	3.1±0.20	43.1±0.11	11.3±0.15	8.2±0.17	27.4±0.35
Summer squash	16.8±0.10	9.4±0.20	44±0.10	14.1±0.11	11.1±0.12	21.3±0.35
Pumpkin	3.9±0.31	2.8±0.18	28±0.10	40.8±0.19	36.1±0.49	11.5±0.22
Bitter gourd	82.6±0.33	56.4±0.76	31.7±0.12	114±0.17	98.7±0.48	13.4±0.15
Colocasia	0.5±0.10	0.3±0.10	40±0.14	20±0.55	16.5±0.17	17.5±0.15
Mean ± SD	26.49 ±31.65	18.47±22.31	33.09±9.22	53.21±40.55	37.24±29.18	28±13.24

Values are mean±SD

A wide variations in β- carotene i.e. 1.1 µg to 122.5 and 0.8 to 98.7 µg /100g was observed in raw and cooked vegetable preparations with mean values of 53.21 and 37.24 µg/100 g, respectively (Table 2). Maximum content of β- carotene was in bitter gourd followed by potato capsicum and minimum was in bottle gourd. The percent loss of β-carotene in vegetable preparation ranged from 11.5 to 53.6% being maximum in brinjal *bhartha* and minimum in pumpkin. Maximum loss was due to open pan cooking of brinjal *bhartha* and minimum loss was due to pressure cooking method used for cooking of pumpkin. Gayatri *et al* (2004) and Nazni and Mythili (2013) reported that β -carotene losses were ranged from 27 to 71% for vegetables cooked by different methods Pressure cooking resulted in better retention of this pro-vitamin as compared to conventional method of cooking. Shruti (2005) reported that the percent losses of β-carotene in vegetable preparations ranged between 19.9 to 30.7%. Bembem and Sadana (2012) reported that the carotene content of the cooked potato samples ranged from 0.12mg/100gm to 0.19mg/100gm being minimum in steamed potato and maximum in sautéed potato although present in small quantity. Cooking significantly ($p<0.05$) affect the carotenoid content of potato.

The calcium content of various vegetable preparations on fresh weight basis varied between 10.6 to 181.87 mg/100g with mean value of 38.2 mg/100g (Table 3). The maximum value was in okra followed by potato beans and minimum value was in pumpkin. Calcium content of raw and cooked vegetables preparation on the dry weight basis is presented in the Table 4. Calcium content of raw and cooked vegetables ranged from 95.3 to 1230 and 59.5 to 1076mg/100g with mean values of 310 and 268mg/100g on dry matter basis, respectively. The losses of calcium content in the vegetable preparations varied between 6.2 to 38.4% with average loss of 15.9%. The maximum loss was in colocasia and minimum was in potato beans.

Table 3: Calcium and iron content of vegetable preparations (per 100 g fresh weight basis)

Vegetable Preparations	Calcium	Iron
Potato beans	53.9±0.01	0.81±0.12
Potato brinjal	20.7±0.05	0.35±0.15
Potato capsicum	15.3±0.03	0.20±0.11
Brinjal *bhartha*	24.3±0.02	0.56±0.25
Okra	181.9±0.06	0.34±0.22
Bottle gourd	24.2±0.01	0.12±0.22
Ridge gourd	18.0±0.07	0.26±0.17
Summer squash	28.8±0.06	0.22±0.22
Pumpkin	10.6±0.01	0.09±0.12
Bitter gourd	29.1±0.04	0.54±0.12
Colocasia	13.0±0.04	0.18±0.14
Mean ± SD	38.2±49	0.33±0.22

Values are mean±SD

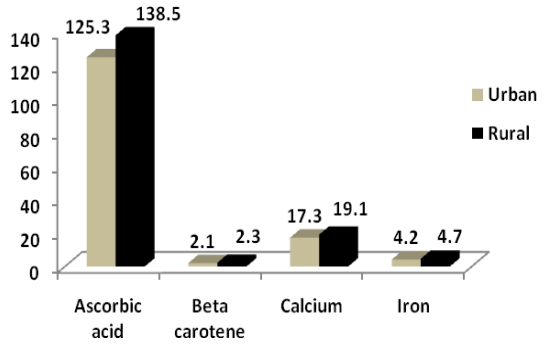

Figure 3.Percent contribution of vegetable preparations to meet Recommended dietary allowances for ascorbic acid acid, beta-carotene, calcium, and iron.

The iron content in different vegetable preparations ranged between and 0.09 to 0.81 with mean values of 0.33mg/100g, respectively on fresh weight basis (Table 3). The highest value was in potato beans and lowest value was in colocasia. Iron content of raw and cooked vegetables ranged from 1.0 to 8.2 and 0.45 to 5.7mg/100g with mean values of 3.5 and 2.4mg/100g on dry matter basis, respectively. The losses of iron content in the vegetable preparations varied between 5.9 to 55% with average loss of 28.8%. The maximum loss was in colocasia and minimum was in potato capsicum (Table 4).

From the results it was observed that both minerals calcium and iron were reduced by cooking. Shruti (2005) reported the average calcium and iron content of vegetable preparations was 81.9 and 1.6mg/ 100g fresh weight with an average loss of 12.9 and 12.6 during preparations and cooking respectively. Results were in line with the results of Ilelaboye *et al* (2013) who reported that all the mineral elements i.e. calcium, phosphorus, potassium, magnesium, iron, manganese, copper and zinc, except sodium (155.14mg/Kg to 4759.80mg/Kg) were reduced by the cooking methods.

Daily vitamin and mineral intake of urban and rural households from common vegetable preparations presented in Table 5. The total vegetable intake in the form for vegetable preparations was 333.3 and 365 g in urban and rural households, respectively. The consumption of both urban and rural households was higher than the suggested intake of ICMR (2003). The average edible

portion of 69.2 and 58.4 for leafy vegetable, 85.5 and 73.2 for roots and tubers and 79.8 and 80.7% for other vegetable was reported by urban and rural households. The daily edible portion of the vegetable used in common vegetable preparations was 271.3 and 300 g for urban and rural households, respectively. Daily per capita consumption of ascorbic acid, β-carotene, calcium and iron was found to be 50.1 mg, 101 µg, 103.6mg and 0.89mg for urban households, respectively. Corresponding value for rural households were 55.4 mg, 111.7 µg 116.6mg and 0.99 mg. The vegetable preparations provided 125.3, 2.1, 17.3 and 4.2% of ascorbic acid, β-carotene, calcium and iron of the recommended level to the urban households, respectively. The corresponding percentages for rural households were 138.5, 2.3, 19.1 and 4.7% (Fig.3). Shurti (2005) reported that during winter season vegetable preparations provided 255.5, 73.5, 47.2 and 12.5 to urban families and 284.3, 81.6, 52.4 and 13.9% to rural families of ascorbic acid, β-carotene, calcium and iron of the recommended level, respectively.

Table 4: Calcium and iron content of raw and cooked vegetable preparations (per 100g dry weight)

Vegetable	Calcium (mg)			Iron(mg)		
Preparations	**Raw**	**Cooked**	**% Loss**	**Raw**	**Cooked**	**% Loss**
Potato beans	407.9±0.61	382.5±0.10	6.2±0.10	6.9±0.13	5.7±0.22	17.4±0.16
Potato brinjal	135.5±0.53	114.3±0.29	15.6±0.15	2.1±0.14	1.9±0.15	9.5±0.12
Potato capsicum	132.4±0.26	120.7±0.21	8.8±0.17	1.7±0.10	1.6±0.10	5.9±0.11
Brinjal *bhartha*	233.9±0.53	213.1±0.94	8.9±0.12	8.2±0.25	5.0±0.11	39.0±0.15
Okra	1230.1±0.95	1076.2±0.96	11.1±0.15	3.6±0.45	2.3±0.11	36.1±0.10
Bottle gourd	307.3±0.17	262.8±0.10	14.5±0.16	1.3±0.19	1.2±0.16	7.7±0.10
Ridge gourd	179.3±0.29	152.6±0.59	14.9±0.25	3.6±0.49	2.2±0.15	38.9±0.15
Summer squash	291.9±0.87	266.6±0.55	8.7±0.15	3.3±0.16	2.0±0.10	39.4±0.13
Pumpkin	196.8±0.65	153.3±0.14	22.2±0.12	1.8±0.14	1.4±0.10	22.2±0.11
Bitter gourd	194.3±0.33	145.6±0.18	25.1±0.13	5.0±0.31	2.7±0.22	46±0.12
Colocasia	95.3±0.48	59.5±0.21	38.4±0.12	1.0±0.13	0.45±0.19	55±0.15
Mean ± SD	309.5 ±318.4	267.9±282.8	15.9±9.4	3.5±2.2	2.4±1.6	28.8±16.9

Values are mean±SD

Table 5: Daily vitamin and mineral intake of urban and rural households from common vegetable preparations

Vegetable intake from vegetable preparations	Urban	Rural
Total vegetable intake ,g	333.3	365
Edible portion,%	81.4	82.2
Edible portion, g	271.3	300
Vitamin and mineral intake from vegetable preparations		
Ascorbic acid, mg	50.1	55.41
β-carotene ,µg	101.0	111.7
Calcium, mg	103.6	114.6
Iron ,mg	0.89	0.99

CONCLUSIONS

The summer vegetable preparations were significant source of ascorbic acid for urban and rural Punjabi households meeting more than 100% of the recommended level, however these vegetable preparations were very small contributors to the daily requirements of nutrients such as β-carotene, calcium and iron during summer. Hence, it is recommended that summer vegetable preparations must be included in the daily diets in order to meet the recommended levels of ascorbic acid which is a vital nutrient for optimum good health.

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