Development and Sensory Evaluation of Beta Carotene Rich Food Preparations Using Underexploited Carrot Greens

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ABSTRACT Carrot greens are the most under-exploited class of greens despite of high nutritional value. In daily diet an increased intake of these inexpensive greens can be one of the strategies for improving the nutritional status. Keeping this in view, the present study was undertaken with the objective to develop commonly consumed food preparations by separately incorporating fresh and dry carrot greens, applying different cooking methods. Levels of incorporation of fresh carrot greens in different food preparations ranged 40 to 80 per cent whereas powder of dry carrot greens was added in different preparations at 7, 8 and 9 per cent levels. Organoleptic evaluation of all food preparations were conducted by a panel of ten judges using Hopkin's seven point scale. In fresh carrot greens incorporated food preparations, the maximum and most acceptable level (80%) of incorporation of under exploited carrot greens was in *saag* and minimum (40%) in *puri* and *kadhi*. In dry carrot greens incorporated food preparations, the most and best level (9 %) of incorporation of greens was in *mathri* and minimum (7%) in *matrey*. Among all the fresh carrot greens incorporated food preparations, *gulabjamun* scored highest (6.96 ± 0.27) overall acceptability scores while *laddoo* scored minimum (5.52 ± 0.68). In dry carrot greens incorporated food preparations *tacques* scored highest (6.31 ± 0.28) and *laddoo* scored minimum (5.98 ± 0.69) overall acceptability scores. Beta carotene content in all food preparations increased significantly ($P \leq 0.01$) with incorporation of fresh as well as dry carrot greens.

INTRODUCTION

Available sub clinical data indicate the high prevalence of Vitamin A deficiency among children (NPCB 1981; Thylefors 1985; UNDP 1992). UNICEF and WHO consider that mortality may reduce by 23 per cent on average by improving the vitamin A status of young children with marginal deficiency. Dietary approaches are needed to replace supplementation programs, ensuring sustainability and adequate coverage. Therefore it is essential that locally available materials which are inexpensive but highly nutritious be used as a vehicle to improve the nutritional status (Negi and Roy 2004).

Carrot, commonly consumed root vegetable is accessible throughout the year in India and other parts of the world. Green leaves of carrot are generally discarded while these leaves are rich source of β carotene as well as iron, calcium, ascorbic acid, folic acid and in appreciable amount of other minerals (Ramadasmurthy and Mohanram 1984; ICMR 1989; Gopalan et al. 2004). In daily diet, an increased intake of these inexpensive under exploited greens can be one of the strategies for improving the nutritional status (Gopalan 1992a, 1996b).

Recognizing the need for the identification of

such unconventional sources which are nutritious, inexpensive, locally available and may be helpful in achieving nutritional security, the present study was undertaken with the objective to develop commonly consumed food preparations by incorporating β carotene rich, inexpensive under exploited greens of carrot, using different methods (deep fat frying, shallow fat frying, pressure cooking, boiling, steaming and roasting) of cooking.

MATERIALS AND METHODS

Materials: The carrot greens were procured from the kitchen garden of Kurukshetra (Haryana), India. They were obtained during the winter season (January-February).

Processing of the Sample: The edible portions of the greens of carrot were separated from stalks, cleaned, washed under running tap water followed by distilled water and dried between folds of filter paper. The fresh carrot greens were divided into two batches and processed as follows:

- cut into even sized pieces with stainless knife and used for different preparations.
- dried in hot air oven at 50°C for 16-18 hours, powdered and stored in airtight containers under refrigerated temperature for further use.

The dried sample as well as fresh sample were

subsequently incorporated into different commonly consumed food preparations.

Development of Food Preparations: Commonly consumed food preparations were prepared by the procedure of Kaur (2007) using different cooking methods commonly applied in homes by separately incorporating fresh and dry carrot greens. Levels of incorporation of fresh greens of carrot in different food preparations were 40, 50, 60, 70 and 80 per cent, whereas, powder of dry carrot greens was added in different recipes at 7, 8 and 9 per cent levels.

Sensory Evaluation: All the developed food preparations were presented to a panel of ten judges and were evaluated organoleptically using Hopkin's seven point scale (1950).

β Carotene Content: β carotene content in controlled as well as carrot greens incorporated food preparations was calculated from the values per 100g of edible portions by using nutritive value of Indian foods (Gopalan et al. 2004).

Statistical Analysis: The data obtained was analyzed statistically (Gupta and Saini 1987). Mean and standard error of mean were calculated for each studied variable. The interpretation of the data so obtained was done by analysis of variance (ANOVA) test. Level of significance was accepted at $P \leq 0.01$.

RESULTS AND DISCUSSION

Sensory Evaluation: The sensory evaluation of the food preparations made by the incorporation of greens revealed that all the food products developed were organoleptically acceptable. However, the acceptable level of incorporation of greens varied in different food preparations. It has also been noticed that when the level of incorporation of greens increased beyond the accepted levels in any preparations, the mean scores for the organoleptic evaluation for appearance, color, texture, taste, flavor and overall acceptability decreased.

Fresh Carrot Greens Incorporated Food Preparations: In fresh greens incorporated food preparations, i.e., *puri* and *kadhi*, the most acceptable level of incorporation was 40 per cent and the scores for overall acceptability awarded by the panel of judges were 6.20 ± 0.52 and 6.80 ± 0.21 , respectively. For *idli*, *gulabjamun*, pancake and *rabri*, the most acceptable level of incorporation was 50 per cent of fresh carrot greens and the respective scores for overall acceptability ranged from 6.20 ± 0.41 (pancake) to 6.96 ± 0.27 (*gulabjamun*). At 60 per cent level of incorporation of fresh greens, *chutney*, cutlets, *chilla*, *pulao* and *gulgulae* were best acceptable

Table 1: Food preparations prepared with different methods of cooking by incorporating fresh and dry leaves powder of Underexploited Carrot Greens (UCG)

Food preparations	Nature of preparations		Leaves incorporated		Method of processing
	Salty	Sweet	Fresh	Dry	
<i>Puri</i>	Salty	-	Fresh	-	Deep fat frying
Cutlets	Salty	-	Fresh	-	
<i>Mathri</i>	Salty	-	Fresh	-	
<i>Matrey</i>	Salty	-	Fresh	-	
Tacques	Salty	-	Fresh	-	
Titbits	Salty	-	Fresh	-	
<i>Gulabjamun</i>	-	Sweet	Fresh	-	Shallow fat frying
<i>Gulgulae</i>	-	Sweet	Fresh	-	
<i>Mathri</i>	Salty	-	-	Dry	
<i>Matrey</i>	Salty	-	-	Dry	
Tacques	Salty	-	-	Dry	
Titbits	Salty	-	-	Dry	
<i>Chilla</i>	Salty	-	Fresh	-	Pressure cooking
Pancake	-	Sweet	Fresh	-	
Soup	Salty	-	Fresh	-	
<i>Saag</i>	Salty	-	Fresh	-	
<i>Pulao</i>	Salty	-	Fresh	-	
<i>Sweet Pulao</i>	-	Sweet	Fresh	-	Boiling
<i>Kadhi</i>	Salty	-	Fresh	-	
<i>Rabri</i>	-	Sweet	Fresh	-	
<i>Idli</i>	Salty	-	Fresh	-	
<i>Laddoo</i>	-	Sweet	Fresh	-	
<i>Laddoo</i>	-	Sweet	-	Dry	Roasting

Table 2: Sensory evaluation of different food preparations with incorporation of fresh underexploited greens of carrot

<i>Food preparations</i>	<i>% level of incorporation</i>	<i>Appearance</i>	<i>Color</i>	<i>Texture</i>	<i>Taste</i>	<i>Flavour</i>	<i>Overall acceptability</i>
<i>Chutney</i>	50	6.10±0.23	6.20±0.35	6.10±0.30	6.40±0.42	6.50±0.24	6.30±0.38
(Sa)	60	6.20±0.28	6.40±0.26	6.30±0.36	6.60±0.38	6.70±0.35	6.40±0.44
	70	6.05±0.19	6.10±0.29	6.10±0.43	6.10±0.39	6.50±0.20	6.20±0.58
<i>Puri</i>	30	6.30±0.51	6.30±0.65	5.90±0.45	6.10±0.19	5.90±0.56	5.90±0.41
(Sa)	40	6.50±0.48	6.40±0.52	6.00±0.32	6.20±0.23	6.00±0.64	6.20±0.52
	50	6.30±0.42	6.20±0.61	5.90±0.38	6.00±0.25	6.00±0.59	6.10±0.64
<i>Cutlets</i>	50	6.00±0.56	6.20±0.35	6.10±0.56	6.10±0.23	5.90±0.58	6.10±0.46
(Sa)	60	6.20±0.45	6.40±0.28	6.20±0.52	6.30±0.35	6.10±0.49	6.20±0.63
	70	5.89±0.42	6.10±0.33	5.90±0.43	6.00±0.30	5.80±0.46	5.90±0.52
<i>Chilla</i>	50	6.30±0.31	6.20±0.56	5.90±0.42	6.00±0.75	6.00±0.68	6.10±0.44
(Sa)	60	6.40±0.25	6.20±0.51	6.00±0.38	6.10±0.62	6.10±0.65	6.20±0.67
	70	6.20±0.38	6.00±0.48	5.90±0.31	6.00±0.51	5.90±0.62	6.00±0.53
<i>Saag</i>	70	6.20±0.40	6.10±0.88	6.00±0.67	6.50±0.62	5.70±0.45	6.10±0.47
(Sa)	80	6.30±0.31	6.20±0.71	6.10±0.52	6.60±0.45	5.80±0.52	6.20±0.45
<i>Pulao</i>	50	6.00±0.54	5.90±0.65	6.00±0.62	5.70±0.82	5.20±0.72	5.80±0.65
(Sa)	60	6.10±0.42	6.10±0.78	6.10±0.55	5.90±0.71	5.20±0.65	5.90±0.71
	70	5.90±0.32	5.90±0.71	6.00±0.43	5.60±0.65	5.10±0.50	5.70±0.51
<i>Kadhi</i>	30	6.60±0.09	6.50±0.18	6.70±0.12	6.20±0.16	6.10±0.08	6.40±0.15
(Sa)	40	6.80±0.02	6.80±0.13	6.80±0.05	6.80±0.12	6.70±0.14	6.80±0.21
	50	6.20±0.12	6.30±0.08	6.10±0.10	6.10±0.09	6.00±0.11	6.10±0.09
<i>Idli</i>	40	6.40±0.52	6.50±0.89	6.10±0.34	6.20±0.53	6.10±0.43	6.30±0.39
(Sa)	50	6.80±0.48	6.70±0.68	6.20±0.45	6.60±0.59	6.40±0.36	6.50±0.48
	60	6.10±0.43	6.10±0.73	6.00±0.38	6.10±0.56	6.00±0.39	6.10±0.52
<i>Soup</i>	60	5.60±0.51	5.70±0.21	5.90±0.29	6.10±0.41	5.50±0.45	5.70±0.29
(Sa)	70	5.90±0.31	5.80±0.27	6.00±0.48	6.20±0.52	5.80±0.27	5.99±0.63
	80	5.50±0.45	5.60±0.18	5.60±0.31	5.80±0.38	5.30±0.19	5.50±0.41
<i>Sweet</i>	60	6.00±0.35	6.00±0.75	6.00±0.62	5.70±0.82	5.20±0.72	5.80±0.34
<i>Pulao</i>	70	6.10±0.49	6.00±0.62	6.10±0.55	5.90±0.71	5.20±0.65	5.90±0.53
(Sw)	80	5.90±0.25	5.90±0.58	6.00±0.43	5.60±0.65	5.10±0.50	5.70±0.48
<i>Gulabjamun</i>	40	6.70±0.41	6.80±0.40	6.80±0.87	6.50±0.81	6.90±0.56	6.70±0.38
(Sw)	50	6.90±0.45	6.90±0.32	7.00±0.82	7.00±0.82	7.00±0.65	6.96±0.27
	60	6.30±0.34	6.60±0.34	6.70±0.79	6.20±0.79	6.70±0.74	6.50±0.49
<i>Gulgulae</i>	50	5.80±0.45	5.70±0.38	5.50±0.41	5.60±0.32	5.10±0.45	5.50±0.21
(Sw)	60	5.80±0.36	5.70±0.35	5.50±0.39	5.80±0.28	5.20±0.42	5.60±0.32
	70	5.70±0.42	5.60±0.41	5.40±0.32	5.50±0.25	5.00±0.38	5.40±0.25
<i>Pancake</i>	40	6.10±0.31	6.40±0.35	6.00±0.35	6.10±0.67	5.90±0.68	6.10±0.32
(Sw)	50	6.20±0.25	6.50±0.41	6.10±0.32	6.20±0.58	6.00±0.76	6.20±0.41
	60	6.00±0.29	6.30±0.32	5.90±0.28	6.00±0.65	5.90±0.81	6.00±0.27
<i>Rabri</i>	40	6.50±0.84	6.70±0.34	6.80±0.71	6.80±0.78	6.80±0.42	6.70±0.22
(Sw)	50	6.80±0.78	6.90±0.42	7.00±0.88	7.00±0.84	7.00±0.62	6.90±0.38
	60	6.40±0.58	6.50±0.38	6.70±0.75	6.60±0.69	6.70±0.74	6.60±0.42

Values are Mean±S.E.

Sw-Sweet Preparation; Sa-Safty Preparation

and the scores for overall acceptability ranged 5.60 ± 0.32 (*gulgulae*) to 6.40 ± 0.44 (*chutney*). Whereas, sweet *pulao* and soup were best acceptable at 70 per cent level of incorporation and respective scores for overall acceptability were 5.90 ± 0.53 and 5.99 ± 0.63 . *Saag* scored highest scores at 80 per cent level of incorporation of fresh greens and the best scores for overall acceptability awarded by the panel of judges was 6.20 ± 0.45 .

Fresh and Dry Carrot Greens Incorporated Food Preparations: *Mathi*, *matrey*, *titbits*,

tacques and *laddoo* were developed by incorporating both fresh carrot greens as well as dry carrot greens separately at different levels. For *mathri*, best level of incorporation of fresh carrot greens was found to be 60 per cent and 9 per cent of dry carrot greens and the scores for overall acceptability were 6.09 ± 0.52 for fresh greens and 6.05 ± 0.63 for dry greens, respectively. *Matrey*, *titbits*, *tacques* and *laddoo* were best acceptable at 50 per cent level of incorporation of fresh greens and the respective scores for overall acceptability ranged from 5.52 ± 0.68

Table 3: Sensory evaluation of different food preparations with incorporation of both fresh and dry leaves of underexploited greens of carrot

Food preparations	% level of incorporation	Appearance	Color	Texture	Taste	Flavour	Overall acceptability
<i>Mathri</i> (fcg)	50	5.80±0.45	5.90±0.41	6.00±0.99	6.05±0.28	6.00±0.83	5.95±0.32
	60	5.90±0.32	6.10±0.48	6.10±0.85	6.10±0.25	6.10±0.76	6.09±0.52
	70	5.70±0.42	5.80±0.30	5.90±0.92	6.00±0.21	5.90±0.69	5.89±0.61
<i>Mathri</i> (dcg)	8	5.90±0.54	5.90±0.62	5.90±0.79	6.00±0.55	5.90±0.85	5.93±0.72
	9	6.00±0.42	6.10±0.45	6.00±0.65	6.10±0.70	6.00±0.69	6.05±0.63
	10	5.90±0.31	5.80±0.53	5.80±0.71	5.90±0.82	5.70±0.72	5.86±0.59
<i>Matrey</i> (fcg)	40	5.90±0.64	5.80±0.68	6.05±0.84	6.10±0.72	5.95±0.79	5.98±0.55
	50	6.10±0.62	6.00±0.74	6.20±0.78	6.20±0.78	6.05±0.81	6.12±0.72
	60	6.00±0.59	5.70±0.65	6.00±0.75	6.00±0.67	5.90±0.77	5.94±0.61
<i>Matrey</i> (dcg)	6	5.90±0.55	5.80±0.74	6.05±0.84	6.10±0.72	5.95±0.81	5.97±0.58
	7	6.00±0.62	6.00±0.68	6.20±0.78	6.20±0.65	6.05±0.65	6.11±0.67
	8	5.90±0.45	5.70±0.65	6.00±0.75	6.00±0.78	5.90±0.77	5.93±0.74
Titbits (fcg)	40	6.20±0.54	6.10±0.59	6.00±0.41	6.00±1.01	5.90±0.73	6.04±0.35
	50	6.30±0.52	6.20±0.64	6.20±0.50	6.10±1.13	6.10±0.65	6.19±0.88
	60	6.00±0.21	5.90±0.53	5.70±0.37	5.80±0.99	5.80±0.69	5.85±0.52
Titbits (dcg)	7	6.30±0.42	6.20±0.39	6.10±0.21	6.10±1.31	6.00±0.45	6.15±0.53
	8	6.40±0.23	6.30±0.24	6.10±0.30	6.10±1.34	6.15±0.31	6.24±0.41
	9	6.10±0.28	5.20±0.43	6.00±0.34	5.90±0.29	6.05±0.48	5.87±0.33
Tacques (fcg)	40	6.20±0.15	6.20±0.12	5.90±0.21	6.50±0.18	6.10±0.22	6.19±0.23
	50	6.50±0.21	6.60±0.19	6.10±0.25	6.70±0.15	6.15±0.19	6.42±0.43
	60	6.10±0.19	6.20±0.15	5.70±0.12	6.40±0.23	6.00±0.15	6.11±0.35
Tacques (dcg)	7	6.20±0.25	6.20±0.12	5.80±0.15	6.40±0.31	6.00±0.25	6.12±0.19
	8	6.40±0.31	6.30±0.15	6.00±0.21	6.50±0.35	6.25±0.20	6.31±0.28
	9	6.10±0.29	6.10±0.21	5.80±0.19	6.20±0.19	6.00±0.19	6.06±0.32
<i>Laddoo</i> (fcg)	40	5.30±0.72	5.60±0.51	5.50±0.98	5.20±0.63	5.10±0.60	5.34±0.65
	50	5.50±0.90	5.70±0.64	5.70±0.74	5.50±0.56	5.15±0.59	5.52±0.68
	60	5.20±0.85	5.40±0.58	5.30±0.61	4.95±0.48	4.95±0.47	5.17±0.59
<i>Laddoo</i> (dcg)	7	5.90±0.51	6.00±0.72	5.80±0.58	5.95±0.51	5.40±0.58	5.82±0.63
	8	6.05±0.63	6.10±0.63	5.90±0.64	6.10±0.64	5.65±0.39	5.98±0.69
	9	5.80±0.48	5.90±0.59	5.60±0.42	5.70±0.43	5.15±0.43	5.66±0.54

Values are Mean ± SE

dcg : preparations prepared by incorporating dry carrot greens.

fcg : preparations prepared by incorporating fresh carrot greens.

(*laddoo*) to 6.42 ± 0.43 (tacques). Titbits, *laddoo* and tacques were best acceptable at 8 per cent level of incorporation of dry carrot greens and scores for overall acceptability ranged from 5.98 ± 0.69 (*laddoo*) to 6.31 ± 0.28 (tacques). *Matrey* were found to be most acceptable at 7 per cent level of dry carrot greens incorporation and the best scores for overall acceptability awarded by the panel of judges was 6.11 ± 0.67 . Statistical analysis for overall acceptability among all food preparations showed that judges were highly consistent in awarding the scores for *gulabjamun* (6.96), *rabri* (6.90), *kadhi* (6.80), *idli* (6.50), *chutney* (6.40), tacques (6.42), titbits (6.24), cutlets, *saag*, *puri*, pancake and *chilla* (6.20), *matrey* (6.12) and *mathri* (6.09).

β Carotene Content: In all controlled (without incorporation) food preparations, β carotene content was zero barring soup, *saag* and *chutney*

but when these food preparations were prepared with incorporation of under exploited greens of carrot either in dry (*mathri*, *matrey*, tacques, titbits) or fresh form (*puri*, *kadhi*, pancake, *rabri*, *idli*, *laddoo*, *gulabjamun*, *chilla*, *pulao*, *guglae*, *sweet pulao*, soup, *saag*, *mathri*, *matrey*, tacques and titbits) at different levels (7, 8, 9, 40, 50, 60, 70 and 80%) their β carotene content significantly ($P \leq 0.01$) increased from 2280 to 4560 μg / 100g. The daily requirement of β carotene of a child / an adult person / ranges from 1200 μg to 2400 μg as recommended by ICMR (1989) and this can be fulfilled by one serving of any of the above said preparations.

CONCLUSION AND RECOMMENDATIONS

Conclusion: All the food products developed with incorporation of greens either in dry form or

Table 4: β carotene content of the most acceptable food preparations based on underexploited carrot greens (UCG)

Food preparations	Per cent level of incorporation of UCG		β carotene ($\mu\text{g}/100\text{g}$)\$		
	Fresh	Dry	Without incorporation of UCG	With incorporation of UCG	
				Fresh#	Dry#
Puri	40	-	-	2280	-
Kadhi	40	-	-	2280	-
Matrey	50	-	-	2850	-
Matrey	-	7	-	-	2280
Tacques	50	-	-	2850	-
Tacques	-	8	-	-	2850
Titbits	50	-	-	2850	-
Titbits	-	8	-	-	2850
Pancake	50	-	-	2850	-
Rabri	50	-	-	2850	-
Idli	50	-	-	2850	-
Laddoo	50	-	-	2850	-
Laddoo	-	8	-	-	2850
Gulabjamun	50	-	-	2850	-
Chilla	60	-	-	3420	-
Pulao	60	-	-	3420	-
Mathri	60	-	-	3420	-
Mathri	-	9	-	-	3420
Gulgulae	60	-	-	3420	-
Cutlet	60	-	-	3420	-
Chutney	60	-	*3091	3420	-
Sweet pulao	70	-	-	3990	-
Soup	70	-	**4006	3990	-
Saag	80	-	***2097	4560	-

* coriander/Mint(2:1) ; ** Spinach; ***Mustard

\$ Gopalan C. (1989)

significant at $P \leq 0.01$

fresh form were organoleptically acceptable. β carotene content in all food preparations increased significantly ($P \leq 0.01$) with incorporation of fresh as well as dry carrot greens. Analysis of data further showed that increase of β carotene was more in food preparations which were prepared with incorporation of fresh carrot greens compared to dry carrot greens.

Recommendations: It is strongly recommended that most of the commonly consumed food preparations can be successfully prepared by incorporating under exploited carrot greens and these preparations if consumed on a daily basis can take care of the micronutrient deficiencies of the population.

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