Original Article

International Journal of Food, Nutrition and Dietetics
Volume 3 Number 1, January - April 2015
DOI: https://dx.doi.org/10.21088/ijfnd.2322.0775.3115.1

The Impact of Storage Period on Chemical Composition of Value Added Supplementary Foods

Neer Kamal Brar*, Balwinder Sadana, Poonam Bakhetia*****

Abstract

Supplementary foods namely *mathi, shakarpara, saviyan, bhujia mix* and biscuits were developed using refined wheat flour (RWF), defatted soy flour (DSF), colocasia leaf powder (CLP) and amla powder (AP). *Mathi* and *shakarpara* supplemented with 7.5% CLP and 5% AP, whereas *saviyan* and *bhujia mix*, supplementation level of CLP and AP was 2.5 % each. In biscuits both powders were added at 5% level. RWF and defatted soy flour were used in the ratio of 4:1. Formulated supplementary foods were nutritionally evaluated in terms of peroxide value, free fatty acid and sugars at an interval of 0, 30, 45 and 60 days. The peroxide value at 0 days ranged from 1.5 (*bhujia mix*) to 3.2 mEq / kg (biscuits) in control, whereas minimum free fatty acid content was observed in *saviyan* (0.09%) and maximum in biscuits as 0.13% in control group. With increase in storage period total and reducing sugars showed non significant increase, whereas non reducing sugars, free fatty acids and peroxide value showed significant increase ($p<0.05$). Hence, developed value added supplementary foods can be easily prepared and stored at domestic level without altering their composition.

Keywords: Supplementary Foods; Value Addition; Peroxide Value; Free Fatty Acid Value and Sugar Content.

Introduction

Iron deficiency anaemia (IDA), along with vitamin A deficiency (VAD) continue to pose a significant challenge to public health to all over India. Anaemia affects more than a billion people of entire world (UNDP, 1998). The prevalence of anaemia was reported to be about 69% in preschool children, 70% in adolescent girls, 74% in pregnant women and 75% in lactating women (NNMB, 2003). Main cause of iron deficiency anaemia is inadequate intake of iron as well as its poor bioavailability from vegetarian diet. A positive correlation between inadequate intake of vitamin A and higher prevalence of anaemia has been demonstrated. Pre-school children are the most vulnerable group of the total population of India (Bhat and Kaur, 2004). In India 52,000 children go blind every year on account of vitamin A deficiency (Pal and Sagar, 2007). Subclinical deficiency of vitamin A is an important cause of childhood mortality and morbidity among children (Laren and Frig, 2001). The three major approaches to combat IDA and VAD are supplementation, food fortification and dietary diversification (Reddy *et al*, 1993). The most rational, sustainable and long term solution therefore lies in increasing the productivity and availability of vitamin A / ß carotene and iron rich foods which ultimately are consumed by vulnerable group of population (Subapriya and Chandrashekhar, 2006, Tang *et al*, 2005). The global public health problems of iron deficiency anaemia and vitamin A can be taken care of by value addition of iron and vitamin C in local food preparation of cereals and pulses available at every door step of Indian home.

Materials and Methods

For the preparation of *mathi, shakarpara, saviyan,* biscuits and *bhujia mix*, refined wheat flour, defatted soy flour, rice flakes, hydrogenated fat, refined oil, sugar, salt and jaggery of good quality were purchased from the local market while colocasia leaves (*colocasia esculenta*) were purchased from local vegetable market. *Amla* (*Emblica officinalis*) was procured from vegetable department of Punjab

Author's affiliation: *M.Sc. Student **Senior Nutritionist Cum Head, Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana, ***Assistant Professor (Food and Nutrition), Krishi Vigyan Kendra, Amritsar.

Corresponding Author: Balwinder Sadana,Senior Nutritionist Cum Head, Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ferozepur Rd, PAU Gate 2., Ludhiana, Punjab- 141004

E-mail: sadana_pau@yahoo.com

Table 1: Methodology Used For Preparation of Supplementary Foods.

Product	Ingredients	Amount (g)	Methods
Mathi	RWF Hydrogenated fat Salt Refined Oil	100 20 5 For frying	Add salt in refined wheat flour and sieve it. Then add hydrogenated fat in flour and knead it to stiff dough. Shape the dough in small balls. Roll the balls into shape of *mathi.* Fry *mathies* in hot oil till golden brown.
Shakarpara	RWF Hydrogenated fat Jaggery Refined Oil	100 20 150 For frying	Add hydrogenated fat in flour then knead into firm dough. Shape the dough in small balls. Roll these balls and cut into diamond shape pieces. Fry pieces in hot oil till golden brown. Prepare jaggery syrup and dip pieces into it.
Saviyan	RWF Hydrogenated fat Salt Refined Oil	100 20 5 For frying	Add salt in refined wheat flour and sieve it. Then add hydrogenated fat in flour, and then knead stiff dough. Pass the dough through hand operated machine. Fry them in *kadahi* into hot oil till golden brown.
Biscuits	RWF Powdered sugar Baking powder Butter Eggs	100 20 ¾ tsp 100 2	Sift the flour and baking powder together two or three times. Cream fat and sifted sugar together till the become light and fluffy. Beat the egg together with vanilla essence to make foam. Add sugar-fat cream and egg foam into flour lightly with fork till smooth dough is formed. Divide the dough into small pieces and make the desired shape of biscuits. Place them on greased baking sheet and bake at 325° F for 15 to 20 minutes.
Bhujia mix	Rice flakes Powdered sugar Salt Peanut Refined Oil	100 20 5 15 For frying	Put some oil in *kadahi* and add rice flakes and peanuts for roasting. Then add powdered sugar and salt in mixture. Roast for 5-8 minutes.

S1= RWF
S2=RWF+DSF (4:1)
S3=S2+7.5/5/2.5% (CLP)
S4=S3+5/2.5% AP

Table 2: Effect of Storage Period on Per-Oxide Value (Meq/Kg) of Supplementary Foods

Time period	Mathi	Shakarpara	Saviyan	Biscuits	Bhujia Mix
0 day					
S_1	2.7±0.05	2.2±0.05	2.2±0.14	3.2±0.07	1.5±0.25
S_2	3.0±0.07	2.0±0.12	3.0±0.11	3.0±0.15	1.2±0.15
S_3	3.1±0.12	2.8±0.07	2.8±0.37	2.8±0.05	1.6±0.07
S_4	2.8±0.25	2.3±0.50	2.5±0.54	3.4±0.50	1.3±0.31
30 days					
S_1	3.2±0.50	3.5±0.23	3.5±0.25	3.8±0.12	2.0±0.32
S_2	4.8±0.50	2.9±0.17	3.8±0.10	3.4±0.17	2.2±0.43
S_3	4.0±0.34	3.2±0.32	3.2±0.22	3.4±0.25	1.8±0.05
S_4	3.5±0.12	3.7±0.25	3.0±0.05	3.9±0.10	1.9±0.07
45 days					
S_1	3.8±0.25	3.8±0.43	4.3±0.13	4.0±0.07	2.2±0.50
S_2	5.0±0.05	3.3±0.23	4.4±0.25	3.9±0.03	2.5±0.13
S_3	4.6±0.20	3.9±0.50	3.8±0.07	3.7±0.25	2.4±0.25
S_4	4.3±0.05	4.2±0.05	3.8±0.05	4.3±0.17	2.2±0.22
60 days					
S_1	4.5±0.07	4.3±0.05	4.9±0.25	4.3±0.06	2.8±0.05
S_2	5.5±0.34	4.1±0.07	5.1±0.03	4.5±0.05	2.6±0.15
S_3	5.1±0.15	4.5±0.15	4.5±0.15	4.0±0.15	2.7±0.23
S_4	5.2±0.19	4.8±0.20	4.4±0.25	4.6±0.25	2.4±0.25
F-Ratio (columns, storage period)	0.62	18.46	10.51	6.34	7.64
CD (5%)	-	0.179	0.425	0.354	0.335
F-Ratio (Rows, Treatments)	18.42	90.45	48.01	67	71.3
CD (5%)	0.362	0.179	0.425	0.354	0.335

Agricultural University, Ludhiana. For processing of the leaves they were thoroughly washed, cleaned, dried in hot air oven at 60±2^{0}C. Dried leaves were ground and sieved to obtain a fine powder and were sealed in air tight zip pouches, whereas *amla* fruits were washed, blanched for 5-7 minutes, deseeded, dried at 60±2^{0}C and grounded to fine powder and stored in air tight container. Developed products were based on RWF as single and with combination of DSF, CLP and AP at different levels of supplementation. The ingredients, amounts and method of preparation used in developing products are given in Table 1.

Table 3: Effect of storage period on free fatty acid (%) content of supplementary foods

Time period	Mathi	Shakarpara	Saviyan	Biscuits	Bhujia Mix
0 day					
S_1	0.12±0.50	0.11±0.15	0.09±0.45	0.13±0.05	0.12±0.05
S_2	0.13±0.07	0.18±0.25	0.11±0.34	0.10±0.07	0.14±0.07
S_3	0.10±0.25	0.15±0.05	0.12±0.23	0.12±0.15	0.14±0.15
S_4	0.11±0.25	0.12±0.50	0.12±0.23	0.10±0.25	0.11±0.25
30 days					
S_1	0.18±0.05	0.18±0.23	0.14±0.05	0.20±0.50	0.22±0.50
S_2	0.15±0.13	0.20±0.12	0.15±0.13	0.25±0.05	0.22±0.25
S_3	0.14±0.35	0.17±0.34	0.13±0.23	0.18±0.12	0.17±0.15
S_4	0.17±0.05	0.20±0.05	0.15±0.25	0.22±0.32	0.20±0.17
45 days					
S_1	0.20±0.07	0.25±0.34	0.17±0.42	0.34±0.23	0.28±0.34
S_2	0.17±0.50	0.28±0.23	0.20±0.50	0.38±0.20	0.23±0.43
S_3	0.16±0.17	0.24±0.12	0.18±0.55	0.23±0.32	0.19±0.05
S_4	0.19±0.43	0.22±0.25	0.20±0.25	0.37±0.12	0.16±0.50
60 days					
S_1	0.31±0.14	0.32±0.34	0.28±0.15	0.40±0.34	0.30±0.34
S_2	0.17±0.20	0.36±0.23	0.26±0.05	0.45±0.12	0.25±0.12
S_3	0.17±0.07	0.28±0.23	0.20±0.15	0.34±0.20	0.27±0.15
S_4	0.20±0.50	0.30±0.23	0.23±0.23	0.41±0.25	0.22±0.34
F-Ratio (columns, storage period)	3.3	2.2	3.1	0.82	5.1
CD (5%)	-	-	-	-	0.031
F-Ratio (Rows, Treatments)	16.45	36.13	7.72	29.0	61.7
CD (5%)	0.043	0.070	0.047	0.034	0.031

Table 4: Effect of Storage on Total Sugars (%) of Supplementary Foods.

Time period	Mathi	Shakarpara	Saviyan	Biscuits	Bhujia Mix
0 day					
S_1	29.8±0.12	39.8±0.12	25.6±0.14	27.8±0.13	39.0±0.11
S_2	32.4±0.11	30.4±0.16	28.4±0.13	29.1±0.17	30.9±0.11
S_3	30.0±0.15	32.1±0.05	31.2±0.17	31.6±0.12	31.4±0.15
S_4	35.2±0.10	37.2±0.14	32.5±0.15	34.0±0.11	37.3±0.13
30 days					
S_1	30.0±0.13	40.1±0.12	25.7±0.13	28.0±0.11	39.4±0.13
S_2	32.4±0.09	31.2±0.14	29.0±0.11	29.7±0.14	31.0±0.10
S_3	30.5±0.13	32.4±0.11	30.6±0.15	31.8±0.15	31.8±0.17
S_4	35.2±0.15	37.5±0.12	32.6±0.14	34.5±0.13	37.6±0.11
45 days					
S_1	30.1±0.13	40.4±0.12	25.3±0.11	28.4±0.13	39.8±0.15
S_2	32.6±0.11	31.5±0.13	29.5±0.15	30.0±0.14	31.4±0.11
S_3	31.0±0.14	32.4±0.11	31.0±0.11	32.0±0.12	32.1±0.14
S_4	35.2±0.12	37.8±0.10	32.8±0.11	34.8±0.09	37.3±0.12
60 days					
S_1	30.1±0.13	40.5±0.14	26.0±0.12	28.7±0.07	39.9±0.12
S_2	32.7±0.10	31.6±0.12	29.7±0.15	30.3±0.14	31.9±0.14
S_3	31.1±0.14	32.6±0.11	31.4±0.17	32.5±0.17	32.7±0.11
S_4	35.5±0.09	38.0±0.13	33.0±0.11	35.0±0.11	37.5±0.13
F-Ratio (columns, storage period)	1128	2840	538	140	2664
CD (5%)	0.386	0.166	0.327	0.719	0.268
F-Ratio (Rows, Treatments)	8.35	69.4	5.0	1.5	19.0
CD (5%)	0.386	0.166	0.327	-	0.265

Table 5: Effect of Storage on Reducing Sugars (%) of Supplementary Foods.

Time period	Mathi	Shakarpara	Saviyan	Biscuits	Bhujia Mix
0 day					
S_1	28.5±0.10	39.5±0.12	25.6±0.14	27.2±0.17	38.7±0.09
S_2	32.0±0.09	30.8±0.09	29.7±0.13	28.4±0.14	30.4±0.15
S_3	28.5±0.15	31.8±0.11	31.2±0.17	31.1±0.15	31.0±0.15
S_4	34.8±0.12	36.7±0.14	31.8±0.15	33.7±0.11	36.7±0.13
30 days					
S_1	28.4±0.12	39.4±0.12	25.5±0.13	26.7±0.11	38.5±0.17
S_2	31.8±0.10	30.7±0.11	29.6±0.11	28.2±0.12	30.0±0.11
S_3	28.3±0.14	31.5±0.16	30.8±0.15	30.8±0.16	30.8±0.12
S_4	34.6±0.11	36.6±0.10	31.6±0.14	33.5±0.13	36.4±0.,13
45 days					
S_1	28.4±0.14	39.3±0.14	25.3±0.11	26.5±0.13	38.1±0.11
S_2	31.5±0.15	30.7±0.13	29.4±0.15	28.0±0.11	29.8±0.14
S_3	28.1±0.16	31.8±0.15	30.4±0.11	30.4±0.15	30.5±0.17
S_4	34.5±0.11	36.4±0.12	31.6±0.11	33.3±0.12	36.2±0.12
60 days					
S_1	28.1±0.08	39.0±0.13	25.2±0.12	26.1±0.11	37.80±0.15
S_2	31.4±0.11	30.5±0.12	29.1±0.15	27.7±0.15	29.71±0.12
S_3	28.0±0.13	31.4±0.11	30.4±0.17	30.0±0.17	30.16±0.11
S_4	34.2±0.13	36.2±0.12	31.1±0.11	33.1±0.14	36.0±0.12
F-Ratio (columns, storage period)	7909	1553	4048	134	27
CD (5%)	0.15	0.23	0.15	0.75	2.4
F-Ratio (Rows, Treatments)	61.4	25.2	21.04	1.4	1.41
CD (5%)	0.15	0.23	0.15	-	-

Table 6: Effect of Storage on Non-Reducing Sugars (%) of Supplementary Foods

Time period	Mathi	Shakarpara	Saviyan	Biscuits	Bhujia Mix
0 day					
S_1	1.32±0.12	0.81±0.12	0.48±0.07	0.61±0.11	0.32±0.17
S_2	0.39±0.11	0.58±0.11	0.41±0.11	0.71±0.13	0.48±0.15
S_3	1.5±0.15	0.24±0.12	0.48±0.12	0.54±0.14	0.42±0.14
S_4	0.33±0.12	0.44±0.13	0.54±0.15	0.24±0.17	0.64±0.17
30 days					
S_1	1.62±0.13	0.65±0.14	0.84±0.16	1.33±0.16	0.94±0.16
S_2	0.58±0.11	0.45±0.11	1.21±0.14	1.50±0.11	1.04±0.11
S_3	2.13±0.14	0.9±0.13	0.58±0.11	1.0±0.13	1.0±0.12
S_4	0.65±0.12	0.74±0.15	0.82±0.13	1.37±0.17	1.41±0.14
45 days					
S_1	1.7±0.15	1.09±0.13	1.03±0.12	1.90±0.13	1.66±0.11
S_2	1.1±0.16	0.87±0.13	1.91±0.17	2.0±0.12	1.62±0.14
S_3	2.89±0.11	0.62±0.15	1.37±0.12	1.62±0.17	1.61±0.15
S_4	0.79±0.14	0.79±0.13	1.04±0.13	1.89±0.11	1.45±0.11
60 days					
S_1	2.02±0.14	1.46±0.11	1.89±0.13	2.61±0.12	1.93±0.09
S_2	1.25±0.14	1.54±0.16	2.22±0.11	2.53±0.09	2.21±0.11
S_3	3.01±0.12	1.18±0.14	2.04±0.15	2.56±0.11	2.55±0.16
S_4	1.34±0.11	1.57±0.13	1.66±0.17	2.37±0.15	1.81±0.13
F-Ratio (columns, storage period)	0.45	2.7	50.8	3.0	1.3
CD (5%)	-	0.237	0.343	-	-
F-Ratio (Rows, Treatments)	38.3	130.3	17.2	32.2	17.4
CD (5%)	0.366	-	0.343	0.359	0.312

The product developed with four modifications were S_1 (With RWF), S_2 (RWF: DSF (4:1), S_3 (S_2 + 2.5/5/7.5% CLP) and S_4 (S_3 + 2.5/5% AP). *Mathi* and *shakarpara* contained 7.5% CLP and 5% AP, whereas

in saviyan and bhujia mix the supplementation level of CLP and AP was 2.5% each. In biscuits both powders were added at 5% level. Samples were stored in zip pouches at room temperature for 60 days. Further products were analyzed at an interval of 0, 30, 45 and 60 days for peroxide and free fatty acid values (Cox and Pearson, 1962), total sugar (Dubois *et al*, 1956), reducing sugar (Nelson, 1944) and non-reducing sugar by the difference in the concentration of total sugar and reducing sugar. The samples were statistically analyzed using analysis of variance (ANOVA).

Results and Discussion

The length of storage period altered the chemical composition of supplementary foods. As the storage period increased the peroxide value and free fatty acids also increased. Among the products highest increase at 0 to 60th day for peroxide value was found in *mathi* (2.7 to 4.5 mEq / kg in S_1) and minimum in biscuits (3.2 to 4.3 mEq / kg). Maximum increase in free fatty acid value was found in control from 0 to 60th days. *Mathi* had highest increase in free fatty acid value (0.12 to 0.20 %) and minimum in *bhujia mix* (0.12 to 0.22) accept *shakarpara*. But in the case of *shakarpara* maximum increase was found in S_2 replication (0.10-0.45). This increase in free fatty acid and peroxide value showed that both type of rancidity i.e. oxidative and hydrolytic took place during storage period (Joshi and Nath, 2002). Peroxide value is oxidative absorption of O_2 in fat / oil.

With increase in storage period peroxide value of products increased significantly. Higher peroxide value indicates higher degree of O_2 absorption. Acid value is an indicative of free fatty acid present in the product. Results revealed that with increase in storage period, the acid value in the form of free fatty acid increased significantly. Higher the acid value more will be FFA and shelf life thus will be less. Similar findings have been observed by Singh and Jha (2005) who reported an increase in FFA value of *shrikhand* at 0, 5, 10, 15 and 20 days of storage period. The reported increase was observed in FFA value as 0.23, 0.34, 0.45, 0.79 and 1.52 %, respectively. Results are also supported by Semwal *et al* (2005) who studied the peroxide value and free fatty acid value of fried sweet *boondi* at 0, 30, 60, 120, 180 and 245 days of storage period. The peroxide value of *boondi* was 3.6, 4.8, 6.5, 9.2, 12.6 nd 18.7 meq O_2 / kg fat and free fatty acid value as 0.35, 0.40, 0.68, 0.81, 0.94 and 1.26 % oleic acid, respectively indicating an increase in peroxide and acid value which reduces the acceptability of fried products with increased storage period.

The increase in total sugars at 60th day of storage for S_1 of all products, the values were ranged between 25.6±0.14 to 26.0±0.12 and 39.8±0.12 to 40.5±0.14, being minimum in sav*i*yan and maximum in *shakarpara*.. The total sugar content for S_2 of all products ranged from 28.4±0.13 to 29.7±0.15 (*saviyan*) and 29.8±0.12 to 32.7±0.10 (*mathi*). Similar trend was followed for S_3 and S_4 modification of each product. Sweet products i. e. *shakarpara*, *bhujia* mix and biscuits had the higher total sugar content as compared to salty ones. The increase in total sugar might be assigned to the hydrolysis of complex carbohydrates (Saika and Saika, 2002).

Deka *et al* (2004) studied the impact of storage on total sugar content of lime-*aonla* spiced beverage. A gradual increase in total sugar was found as 8.8, 10.1, 10.6 and 10.6 % at 0, 2, 4 and 6 months respectively. Reducing sugars were found to decrease with an increase in storage period. The decrease in reducing sugars till 60th day of storage for S_1 modification of *mathi* ranged between 28.5±0.10 to 28.1±0.08, similar trend followed for all modifications of each product. Premavalli *et al* (2001) analyzed reducing sugar content in carrot-pumpkin *halwa* packed in polypropylene (PP) at 0, 1, 2, 3 and 4 months storage period to be 25.5, 32.5, 39.5, 63.5 and 45.9 g glucose / 100g, respectively. The change in reducing sugar and total carbohydrate are accounted for on the basis of acid catalyzed sucrose hydrolysis mechanism. This involves the protonation of glucose oxygen followed by glycosic bond to form mono saccharides in the form of carbonium ion. Fructose carboxinium (Fru^+) reacts with water to form two fructose units and another fructose to form difructose phenolic (PPCC) coloured compound. These changes occurred for gradual rise in the color reducing and reducing sugar (Jones and Smith, 1999).

The increase in non-reducing sugars from 0 to 60th day of storage for S_1 of all products was 1.32±0.12 to 2.02±0.14 (*mathi*), 0.81±0.12 to 1.46±0.11 (*shakarpara*), 0.48±0.07 to 1.89±0.13 (*saviyan*), 0.61±0.11 to 2.61±0.12 (biscuits) and 0.32±0.17 to 1.93±0.09 (*bhujia* mix). Similar trend was followed for all modification of each developed supplementary foods.

Singh *et al* (2000) analyzed reducing sugar, non-reducing sugar and total sugar in soy fortified biscuits. The corresponding values were found to be 1.93, 18.9 and 20.9%, respectively.

Conclusion

An increase in peroxide value, FFA and sugars was observed with an increase in storage period.

Maximum increase was observed in S_1 as a control for peroxide value and free fatty acid. The highest increase was observed at 60th day in all modification of each product. In the case of total sugars the highest increase at 60th day was recorded for each product. The maximum reduction in reducing sugar of all products was analyzed at 60th day of storage period. In the case of non-reducing sugars, all the products had maximum increase till 60th day of storage. With increase in storage period, total and reducing sugars showed non significant increase, whereas non reducing sugars, free fatty acids and peroxide value showed significant increase ($p<0.05$). Hence, developed value added products can be easily prepared and stored at domestic level and if incorporated in daily diet can significantly reduce the micronutrient deficiency.

References

1. Bhat N and Kaur J. Anthropometeric measurements of pre-school boys. *Ind. J. Nutr. Dietet*. 2004; 41**:** 113-117.
2. Cox HE and Pearson D. The chemical analysis of foods. Chemical publishing Co. Inc. Newyork,1962; 41 (3): 421, 329-332.
3. Deka BC, Sethi V, Poonam S and Sivastava VK. Physico-chemical changes of lime-aonla spiced beverage during storage. *J. Food Sci. Technol*.,2004; 41(3):329-332.
4. Dubois M, Gilles KA, Hamilton JK, Rebers PA and Smith F. Colorimetric method for determination of sugars and related substances. *Anal. Chem*. 1956; 28: 350-354.
5. Jones JKN, Smith F. Advances in carbohydrate chemistry. Academic Press, New York. 1999: 4: 253.
6. Joshi S and Nath N. Effect of pre-treatment on quality and shelf life of fried chips from sprouted tubers of potato variety "kufri chanadarmukhi". *J. Food Sci. Technol*. 2002; 39(3): 251-257.
7. Laren MDS and Frigg M. Sight and life book on vitamin A in health and disease, Second edition, Task for sight and life, Switzerland, 2001.
8. Nelson N. A photometric adaption of Somogyi method for the determination of glucose. *J. Bio.Chem*.:1944; 153: 375-380.
9. NNMB. National Nutrition Monitoring Bureau. Report on food and nutrient intakes of individuals-rural. National Institute of Nutrition, Indian Council of Medical Research, Hydrabad, 2003.
10. Pal R and Sagar V. Correlates of vitamin A deficiency among Indian rural preschool age children. *Eur J Ophthalmol.*, 2007; 17 (6) 1007-1009.
11. Premavalli KS, Majumdar TK and Madhura CV. Processing effect on color and vitamins of green leafy vegetables. *J Fd Sci Technol.,2001*; 38 (1) 79-81.
12. Reddy V, Prahlad RN, Sastry JK and Kashinath K. Nutritional trends in India. NIN, ICMR, Hyderbad, India, 1993; 43-45.
13. Saika L and Saika J. Processing of Ou-tenga (*Dellenia indica*) fruit for preparation of squash and its quality changes during storage. *J. Food Sci. Technol.*, 2002; 39(2):149-151.
14. Semwal AD, Sharma GK, Khan MA, Roopa N, Srihani K and Bawa AS. Keeping quality of fried sweet *boondi*. *J Food Sci Technol*.,2005; 42 (3): 285-287.
15. Singh R and Jha YK. Effect of sugar replacers on sensory attributes, biochemical changes and shelf life of *shrikhand*. *J Food Sci Technol.*, 2005; 42 (2): 199-202.
16. Singh R, Singh G and Chauhan GS. Nutritional evaluation of soy fortified biscuits. *J Food Sci. Technol*., 2000; 37 (2):162-164.
17. Subapriya MS and Chandrashekar U. Vitamin supplementation – impact on mineral vitamin A deficiency. *Ind J Nutr Dietet.,*2006; 43: 330-336.
18. Tang G, Qin J, Dolnikowski G, Russel G and Grusak MA. Spinach or Carrots can supply significant amounts of vitamin A as assessed by feeding with intrinsically deuterated vegetables. *Am J Clin Nutr.,*2005; 82:821-828.
19. UNDP. Human Development Report 1998, Oxford University Press, Newyork.