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Chemical and Oxidative Changes in Fried Bitter Gourd and Onion During Storage

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The present study was carried out to extend the shelf life of the fried bitter gourds and onions by the addition of antioxidant in soyabean oil during frying process. Chemical and oxidative changes in fried bitter gourds and onions were also investigated during storage. Crude protein and mineral contents of both the fried vegetables remained unchanged. However, reduction in moisture contents along with marked increase in fat contents was observed in fried vegetables. Significant improvement in protein digestibility was also observed in both the vegetables after frying. Addition of antioxidant in the frying oil remarkablly reduced FFA and POV of processed vegetables during storage at 25° and 45°C. Addition of 2% antioxidant reduced FFA from 0.346 to 0.079% and POV from 91.6 to 30.0 meq kg^{-1} at 45°C on storage of fried bitter gourds while in case of onions, FFA from 0.372 to 0.055% and POV from 121.6 to 0.102 meq/Kg during storage for six months. Subjective evaluation studies showed that these processed vegetables, on six months storage at 45°C, were organoleptically acceptable. Therefore, it is concluded that addition of 2% antioxidant extended the shelf life of the fried vegetables up to six months.

Key words: Bitter gourd, Onion, Storage temperatures, Chemical and oxidative changes.

Introduction

Biochemical and oxidative changes occure in food-stuffs during storage at elevated temperature (Kumar and Singh 1984; Grandgirard and Julliard 1987; Rojo and Perkins 1987; Onigbinde and Akinyele 1988; Sebedio *et al* 1991; Maila and Marino 1994; Krishna *et al* 1994). Development of rancidity is the result of oxidative change which adversely affects the rheological properties of fatty food materials. Fat and fatty food materials are easily deteriorated by oxidative rancidity from the reaction with atmospheric oxygen and the hydrolytic reactions catalyzed by lipases (Allen and Homilton 1983). Natural and synthetic antioxidants are widely used in many foods to prevent the development of fat rancidity during storage (Aust and Thomson 1981; Praseed and Gupta 1984; Sebedio *et al* 1990).

It is a common practice that most of the food materials are fried before use. Potato chips and french fries are prepared by deep fat frying process. Similarly, bitter gourds and onions are fried in oil or fat before cooking. Preparation of bitter gourds before cooking is a lengthy and laborious method and fried bitter gourds can not be stored for longer period due to the development of rancidity. Therefore, it is inevitable to develop a simple process to suppress the on set of rancidity of the fried bitter gourds and onions using some suitable antioxidant.

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Keeping in view the deleterious affect of fat deterioration, present study was undertaken to prolong the storage life of fried bitter gourds and onions. Bitter gourds and onions were fried in soya bean oil containing an antioxidant. The objective of these studies was to investigate the effect of storage temperature and time on the oxidative and chemical changes in fried bitter gourds and onions.

Materials and Methods

Bitter gourds (*Momordica charentis*) and onions (*Allium cepa*) were purchased from the local market to carry out these studies. Non edible portions of the vegetables were removed manually with sharp knife whereas edible portion of bitter gourds and onion was chopped with electric chopper. Embinox (18% BHA +20% BHT) was used as an antioxidant. This antioxidant was supplied by Rhone-Poulenc Chemicals (Pvt.) Ltd. Lahore to study the effect of antioxidant on rancidity development. Chopped bitter gourds and onions were fried as given below:

Frying of bitter gourd and onion. One Kg chopped bitter gourds were thoroughly mixed with 100 g of common salt (NaCl) and rubbed for removing the bitterness. After 2 hr, salt and water was drained off and then washed twice with tap water. After salt treatment, were dried at 60°C for 4 h. 100 g of dried bitter gourd were fried in 300 ml of soyabean oil with and without antioxidant (Embinox). An-

tioxidant was added at the rate of 1% and 2% (V/V) in oil. After frying, excess oil was drained off, vegetables were blotted and stored in air tight glass jars at 25° & 45°C. Dried onions were also fried in similar manner.

The amount of oil in both the fried vegetables during storage was kept about 7%. The processed samples were withdrawn periodically after an interval of one month and then analyzed for FFA and POV to asses the rancidity during storage. The investigations were continued upto a storage period of six months.

Chemical analysis. Moisture contents of the dried bitter gourds and onins were estimated by placing a ground sample (3-5 g) at 100+5°C in an oven for 20-24 h till a constant weight was attained, whereas ash content was determined after ignition at 550±5°C in a muffled furnace for a period of 4 h (AOAC 1984). Crude protein content were estimated after digestion with conc. sulphuric acid using $CuSO_4$: K_2SO_4: SeO_2 (1:9:0.02) as catalyst according to Micro Kjeldahl method (AOAC 1984). Fat contents were extracted with n-hexane, whereas crude fibre was measured after digestion with 1.25% sulphuric acid and 1.25% sodium hydroxide as described in AOAC (1984) Protein digestibility was measured in vitro after digestion with pepsin-HCl solution at 37.5°C for 24 h (Price *et al* 1979). Peroxide value (POV) was measured by titration with 0.01N sodium thiosulphate solution using starch as indicator, whereas free fatty acids (FFA) were estimated using alkali titration method (AOAC 1984). Data of fried bitter gourds and onions were recorded and statistically analyzed according to Steel and Torrie method (Steel and Torrie 1980). Differences between treatments at 5% level were considered significant.

Table 1
Chemical composition of bitter gourd and onion before and after frying

Parameters (%)	Bitter gourd		Onion	
	Before frying	After frying	Before frying	After frying
Moisture	7.02±0.82	4.73±0.73	9.42±0.82	5.01±0.75
Protein	7.14±0.77	7.08±0.69	6.82±0.76	6.77±0.77
Fat	4.02±0.82	7.32±0.71	3.89±0.71	7.11±0.79
Crude fibre	2.62±0.92	2.49±0.65	2.55±0.69	2.46±0.81
Ash	18.70±0.87	18.67±0.58	19.13±0.89	19.09±0.88
Protein digestibility	40.27±0.88	51.26±0.77	39.67±0.73	50.96±0.87
Protein digestibility after six months storage at 45°C	40.00±0.76	51.37+0.69	39.80+0.77	50.88+0.93

*Average of three determinations along with standard deviations.

Table 2
Effect of storage conditions on free fatty acids (FFA) and peroxide values (POV) of fried bitter gourd

Storage time (months)	25°C		45°C	
	POV meq kg^{-1}	FFA (%)	POV meq kg^{-1}	FFA (%)
0	1.8±0.12	0.032±0.16	1.8±0.12	0.032±1.6
1	13.3±0.42	0.055±0.02	18.7±0.72	0.076±0.02
2	20.6±1.2	0.108±0.02	27.6±1.6	0.137±0.06
3	36.8±1.7	0.142±0.03	41.3±1.7	0.166±0.07
4	47.3±1.6	0.193±0.07	59.9±1.2	0.212±0.06
5	69.8±1.7	0.261±0.03	78.0±1.3	0.289±0.07
6	78.6±1.3	0.293±0.04	91.3±1.6	0.346±0.09

*Average of three determinations along with standard deviations.

Table 3
Effect of storage conditions on free fatty acids (FFA) and peroxide values (POV) of fried onion.

Storage time (months)	25°C		45°C	
	POV meq kg^{-1}	FFA (%)	POV meq kg^{-1}	FFA (%)
0	2.3±0.26	0.039±0.04	2.3±0.21	0.039±0.01
1	18.0±1.1	0.061±0.02	23.6±01.2	0.083±0.02
2	37.8±2.0	0.121±0.06	45.6±.1.8	0.132±0.01
3	61.0±1.7	0.162±0.01	77.8±1.7	0.176±0.06
4	71.2±1.7	0.198±0.02	90.2±1.6	0.212±0.05
5	82.9±1.3	0.282±0.02	102.5±2.0	0.296±0.04
6	91.3±1.8	0.324±0.03	121.6±2.1	0.372±0.03

*Average of three determinations along with standard deviations.

Results and Discussion

Table 1 shows the chemical composition of bitter gourds and onions before and after frying in soya bean oil. Crude protein, fibre and minerals (ash) contents of bitter gourds and onions did not change at all after frying. However, moisture contents of bitter gourds and onions were reduced by 32.62% and 46.81% respectively, whereas 82% increase in fat contents were observed in both the vegetables as result of frying. Protein digestibility of bitter gourds and onions was also increase by about 28% after frying in oil. However, no change in protein digestibility was observed after storage at 45°C for six months. Improvement in protein digestibility could be the result of heat treatment due to which some structural changes might have occurred in protein profile, consequently increasing the accessibility of proteins to enzymatic attack. These results are in agreement with the findings of other workers who reported marked improvement in protein digestibility due

Table 4

Effect of antioxidant and storage conditions on free fatty acids (FFA) and peroxide values (POV) of fried bitter gourd

Storage time (months)	25°C				45°C			
	POV meq kg^{-1} Antioxidant		FFA(%) Antioxidant		POV meq kg^{-1} Antioxidant		FFA(%) Antioxidant	
	1%	2%	1%	2%	1%	2%	1%	2%
0	1.8	1.8	0.032	0.032	1.8	1.8	0.032	0.032
	±(0.2)	±(0.27)	±(0.02)	±(0.01)	±(0.27)	±(0.27)	±(0.02)	±(0.02)
1	4.0	2.9	0.044	0.037	6.1	4.0	0.050	0.042
	±(0.02)	±(0.6)	±(0.02)	±(0.03)	±(1.21)	±(1.1)	±(0.04)	±(0.01)
2	5.9	4.1	0.051	0.042	8.3	6.2	0.056	0.050
	±(0.1)	±(1.1)	±(0.04)	±(0.04)	±(1.0)	±(1.2)	±(0.04)	±(0.06)
3	15.7	12.0	0.058	0.052	22.2	17.0	0.067	0.053
	±(1.2)	±(2.0)	±(0.02)	±(0.03)	±(1.1)	±(1.6)	±(0.04)	±(0.06)
4	21.0	17.5	0.066	0.060	28.8	21.6	0.076	0.062
	±(1.2)	±(1.9)	±(0.04)	±(0.03)	±(1.2)	±(1.2)	±(0.02)	±(0.03)
5	29.7	21.0	0.077	0.071	33.4	28.8	0.089	0.074
	±(1.3)	±(1.6)	±(0.06)	±(0.04)	±(1.0)	±(1.7)	±(0.02)	±(0.02)
6	31.0	23.5	0.081	0.073	34.4	30.0	0.092	0.079
	±(1.4)	±(1.1)	±(0.04)	±(0.04)	±(2.0)	±(1.9)	±(0.03)	±(0.07)

*Average of three determinations along with standard deviation.

Table 5

Effect of antioxidant and storage conditions on free fatty acids (FFA) and peroxide values (POV) of fried onion.

Storage time (months)	25°C				45°C			
	POV meq kg^{-1} Antioxidant		FFA(%) Antioxidant		POV meq kg^{-1} Antioxidant		FFA(%) Antioxidant	
	1%	2%	1%	2%	1%	2%	1%	2%
0	2.3	2.3	0.039	0.039	2.3	2.3	0.039	0.039
	±(0.4)	±(0.4)	±(0.03)	±(0.03)	±(0.4)	±(0.4)	±(0.03)	±(0.03)
1	5.0	4.4	0.049	0.040	6.1	3.9	0.052	0.044
	±(1.1)	±(1.2)	±(0.03)	±(0.02)	±(1.2)	±(1.0)	±(0.04)	±(0.040)
2	5.8	5.1	0.060	0.048	7.3	5.8	0.066	0.052
	±(1.2)	±(0.9)	±(0.02)	±(0.02)	±(1.1)	±(1.0)	±(0.03)	±(0.06)
3	16.6	13.7	0.068	0.056	18.0	15.5	0.078	0.059
	±(2.0)	±(1.3)	±(0.06)	±(0.04)	±(2.0)	±(1.1)	±(0.02)	±(0.04)
4	23.1	21.0	0.079	0.067	25.5	20.6	0.086	0.070
	±(1.8)	±(1.9)	±(0.04)	±(0.06)	±(2.1)	±(1.2)	±(0.03)	±(0.03)
5	31.0	28.5	0.083	0.073	32.5	29.7	0.096	0.075
	±(1.6)	±(1.7)	±(0.03)	±(0.04)	±(2.0)	±(1.3)	±(0.04)	±(0.029)
6	35.0	30.0	0.089	0.081	36.9	32.6	0.102	0.088
	±(1.5)	±(1.0)	±(0.03)	±(0.04)	±(0.9)	±(1.0)	±(0.027)	±(0.027)

*Average of three determinations along with standard deviation.

to heat treatment Ven der (P 1990). Statistical analysis of this data showed that protein digestibility was significantly improved ($P<0.05$) due to frying rocess.

Free fatty acids and peroxide values after frying. Free fatty acids (FFA) and peroxide values (POV) of the fried bitter gourds and onions are given in Table 2 and 3. A gradual increase in FFA and POV was observed on storing the fried bitter gourds and onions at 25° & 45°C. However, increase in FFA and POV was more pronounced at 45° than at 25°C. Initially, amount of FFA and POV of fried bitter gourds was 0.032% and 1.8 meq kg^{-1} respectively (Table 2). After six months storage, FFA values at 25° & 45°C were found to be 0.293 & 0.346% respectively. However, POV of the fried bitter gourds at 25° & 45°C were 78.6 and 91.6 meq kg^{-1} respectively. Results reported in Table 3 revealed that FFA and POV of the fried onions were 0.039% & 2.3 meq kg^{-1} respectively at the start of experiment. FFA of the fried onions stored at 25° and 45°C increased to 0.324 and 0.372% respectively, whereas POV were found to be 91.3 at 25°C and 121.6 meq kg^{-1} at 45°C after six months storage. It is evident from these results that storage temperature and time caused deterioration of vegetable oil to great extent. Generally, it is conceded that the principal route of this deterioration is through oxidative rancidity, which takes place at double bond in triglyceride molecule (Rundberg 1976). In fat deterioration, the first initiating step is the formation of free fatty radicals which are susceptible to oxygen attack in the presence of light, resulting in formation of many organic compounds and free fatty acids (Akhtar *et al* 1985). Production of free fatty acid and the increase in peroxide values are the best predictors of fat deterioration which could be used to monitor the extent of oils spoilage (Sattar and Deman 1973; Stevenson *et al* 1984).

Free fatty acids and peroxide values after the addition of antioxidant. Addition of antioxidant in variable amount resulted in significant reduction of free fatty acids and peroxide values of fried bitter gourds during storage (Table 4). The addition of 1% antioxidant (Embinox) reduced FFA from 0.293 to 0.081% at 25°C and from 0.346 to 0.092% at 45°C after six months storage of fried bitter gourds (Table 4). Addition of 2% antioxidant further reduced FFA to 0.073% and 0.079% at 25° & 45°C respectively upto a storage period of six months. Similarly, addition of 1% antioxidant caused reduction in POV from 78.6 to 31.0 meq kg^{-1} at 25°C and from 91.6 to 34.4 meq kg^{-1} at 45°C after six months storage. The POV values were reduced to 23.5 meq kg^{-1} and 30.0 meq kg^{-1} at 25° and 45°C on the addition of 2% antioxidant. These results indicated that addition of different concentrations of antioxidant exhibited antioxidative activity in comparison with control 2% addition of antioxidant showed a further decline in FFA upto 77% (0.346-0.079%) and POV upto 67% (96.6-30 meq kg^{-1}) in fried bitter gourds stored at bitter 45°C for a period of six months. Rancidity of fried onion was also reduced to great extent by the addition of antioxidant (Embinox) in variable amount in soyabean oil during frying (Table 5). The addition of antioxidant (1%) reduced FFA from 0.324% to 0.089% at 25°C and 0.372% to 0.102% at 45°C after six months storage. These values were further reduced to 0.081% and 0.088% at 25° & 45°C respectively by the addition of 2% antioxidant. POV of fried onions were reduced from 91.3 meq kg^{-1} to 35.0 meq kg^{-1} at 25°C and from 121.6 meq to 36.9 meq kg^{-1} at 45°C by the addition of 1% antioxidant. POV became 30.0 meq kg^{-1} and 32.6 meq/kg at 25° & 45°C respectively by the addition of 2% antioxidant. These results are in consistent with the findings of Kiyomi and Yasuko (Kiyomi and Yasuko 1995) who reported that lipid peroxides were significantly reduced by the addition of antioxidants in processed foods. Kathy *et al* (1994) suggested that addition of BHA along with other antioxidants inhibited food deterioration during storage at both high and ambient temperatures. Statistical analysis of the data revealed that FFA and POV of bitter gourds & onions were significantly reduced ($P<0.05$) by the addition of 2% antioxidant in the oil during frying process. Organoleptic evaluation of the fried bitter gourds and onions was also carried out by a trained taste panel after six months storage. Overall acceptability of the control samples was very poor. After six months storage at 45°C, samples of bitter gourds and onions fried in oil containing 2% "Embinox" were readily acceptable as for as their colour flavour and taste were concerned. Therefore, it may be concluded that bitter gourds and onions after frying in oil containing 2% antioxidant, can safely be stored in air tight containers for six months at 45°C.

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