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Studies on development of low sodium chicken strips

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ABSTRACT : A process for rehydratable shelf stable low sodium chicken strips (LSCS) from spent hen meat to use in soups, curries, stews etc. was developed. On the basis of preliminary trials of various salt replacers and their effects on physio-chemical attributes three treatments were finalised, *viz.*, spent hen meat strips treated with NaCl and KCl in 50:50 (T_1), spent hen meat strips treated with NaCl and $MgCl_2$ in 60: 40 (T_2), spent hen meat strips treated with NaCl and $CaCl_2$ in 70: 30 (T_3), were compared with spent hen meat strips treated with NaCl 100 per cent as control to check the influence of these treatments on sensory attributes. The LSCS were analyzed for proximate composition and sodium on 0^{th} day, change in pH, water activity, tyrosine value and TBARS value as well as microbial parameters during storage at ambient temperature were also performed at 10 days interval for total period of 30 days. All the treated and control exhibited similar amount of protein (79.49-81.83 %) and fat (3.36-3.83 %). A progressive increased was noticed during storage study in the water activity, pH, TBARS value, tyrosine value and total plate count with advancement of storage period. In sensory aspects, LSCS treated with NaCl: KCl (T_1) was significantly ($P<0.01$) superior over the other two treatments when compare with control. Low sodium chicken strips (LSCS) could be successfully manufactured by replacing 50 per cent NaCl with KCl.

KEY WORDS : NaCl, KCl, $MgCl_2$, $CaCl_2$, TBARS, pH

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INTRODUCTION

Sodium is a critical component of the human diet and is necessary to regulate many of the body's physiological functions. last decade there has been a renewal of interest in sodium reduction in the human diet, particularly in the Western countries. This interest has been developed by rather compelling evidence that excess sodium intake is a major cause of high blood pressure levels (Dickinson and Havas, 2007; Karppanen and Mervaala, 2006; He and acGregor, 2008), and that hypertension leading to cardiovascular disease can be prevented by decreasing dietary sodium intake (Cutler and Roccella, 2006; Cook *et al.*, 2007). The major source of common salt is diet and excess salt in the food creates panic among health-conscious consumers. the amount of added salt to foodstuffs has become a major issue for the processed food sector, including the meat industry (MacGregorand Sever, 1996; MacGregor and De-Wardener, 2002). The World Health Organization (WHO) has deemed the evidence "conclusive" that excess sodium causes hypertension and has advocated world-wide reformulation of processed and prepared foods to achieve the lowest possible sodium content (WHO, 2006). Salt reduction initiatives, such as the National Salt Reduction Initiative (NSRI), aim to reduce salt in the American diet by 20 per cent over a five year period, starting in 2010 (Wenther, 2010). Sodium chloride (NaCl; salt) is the major dietary source of sodium and is one of the oldest and most familiar food ingredients known to man.

Sodium chloride is one of the most frequently used ingredients in meat processing. Sodium chloride affects flavour, texture and shelf-life of meat products. Besides the perceived saltiness, the NaCl brings out the characteristic taste of the meat product enhancing the flavour (Gillette, 1985). Sodium chloride also has an important role in the texture of meat products. It improves the water and fat binding properties of

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meat products resulting in the formation of a desirable gel texture upon cooking (Terrell, 1983). The preservative effect of NaCl is primarily due to its ability to lower water activity (Marsh, 1983; Sofos, 1984).

There are several approaches for reducing the sodium content in processed meats: (1) lowering the level of sodium chloride (NaCl) added; (2) replacing all or part of the NaCl with other chloride salts (KCl, $CaCl_2$, and $MgCl_2$); (3) replacing part of the NaCl with non-chloride salts, such as phosphates, or with new processing techniques or process modifications; and (4) combinations of any of the above approaches (Sofos, 1984, 1986, 1989; Terrell, 1983).

MATERIAL AND METHODS

The present experiment on development of low sodium chicken strips from spent hen meat was performed in various phases. The materials used and methodology employed during the study are discussed here under.

Salt substitutes :

Different salt substitute such as Potassium chloride, Calcium chloride and Magnesium chloride were procured from standard firms *viz.*, Himedia Chemicals Pvt. Ltd. and S.D Fine Chemicals Pvt. Ltd., etc.

Preliminary trials for standardization of process for low sodium chicken strips :

In the present investigation, before finalizing the process for making low sodium chicken strips preliminary trials were conducted on various aspects and bests among all were selected for further trials on the basis of rehydration properties and visual observations.

Selection of suitable muscles of the spent hen for proper slicing:

In the preliminary experiment, chicken strips were prepared from leg muscles and breast muscles of the spent hen. Leg muscles were difficult to slice and after drying, the shreds from leg muscles were exhibiting unappealing dark colour. Breast muscles were selected for further trials, as these strips were giving better appearance after drying.

Selection of slicing technique :

In the preliminary studies, it was observed that slicing of fresh spent hen muscles was difficult, Therefore, spent hens muscles were frozen overnight for ease of slicing and to minimize fluid loss.

Selection of levels and types of salt substitute :

Most of the dried meat or fish products are subjected to salt treatment before drying. This may lead to health problems associated with salt intake. In present investigation different salt substitutes were tried in the preliminary studies. Initially spent hen strips were treated with various salt substitutes (KCl, $MgCl_2$, $CaCl_2$) in combination with NaCl in different proportions (50, 40 and 30 %) separately before drying. The amount of the salt mixture was about 10 per cent of the weight of the chicken strips. On the basis of salt content, drying behaviour and some sensory attributions of treated spent hen strips following combination of salt and salt substitutes were selected for further studies.

T_1 = Spent hen meat strips treated with 50 per cent NaCl and 50 per cent KCl as salt substitute.

T_2 = Spent hen meat strips treated with 60 per cent NaCl and 40 per cent $MgCl_2$ as salt substitute.

T_3 = Spent hen meat strips treated with 70 per cent NaCl and 30 per cent $CaCl_2$ as salt substitute.

C = Spent hen meat strips treated with 100 per cent NaCl.

Process for preparation of low sodium chicken strips from spent hen meat is described in Fig. A.

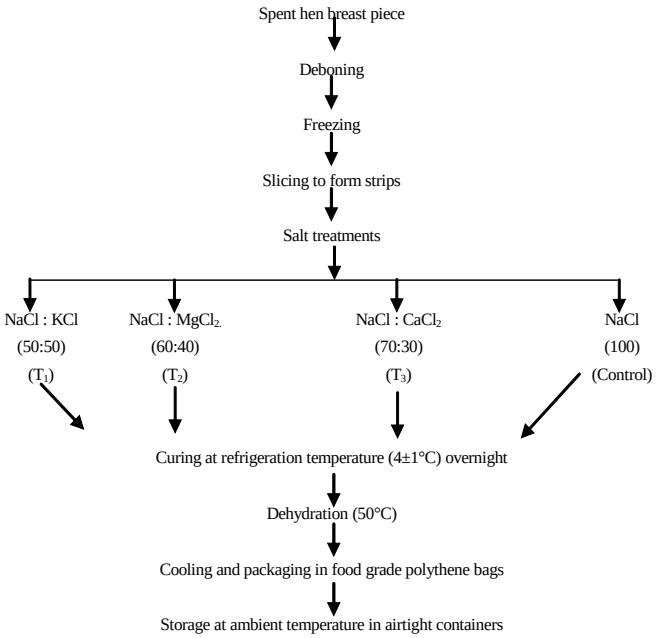

Fig. A : Process for preparation of low sodium chicken strips

Packing and storage :

Cooled chicken strips were packed in food grade polythene bags and stored in airtight containers at ambient temperature for monitoring the shelf life of dehydrated flavoured chicken strips at ambient temperature.

Rehydration properties :

Rehydration ratio :

The rehydrated weight of the sample after soaking for 10 minutes in water at 100°C divided by initial weight of the sample was expressed as the rehydration ratio (Guizani *et al.*, 2008).

Proximate composition :

The moisture, crude protein and fat contents of dehydrated low sodium chicken strips were determined as per the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

Moisture :

Around ten grams accurately weighed sample was placed in hot air oven at 100±1°C for 16-18 hours. After cooling it in desiccator for ten min, the loss of moisture was determined and expressed as per cent moisture of sample.

Fat :

Accurately weighed samples of strips in thimbles were dried overnight at 50°C in hot air oven. The fat was extracted with petroleum ether (BP 60-80°C) in Soxhlet's apparatus. Extracts in oil flask was dried at 60°C in hot air oven for overnight. Next day the oil flask was cooled and weighed. Ether extract was calculated by difference in weight of dried oil flask before and after extraction.

Crude protein :

Nitrogen content of strips was estimated by the Kjeldahls method and protein content was expressed by multiplying the nitrogen value with constant factor 6.25 and taken as the crude protein content in the sample.

Physico- chemical analysis :

The phsico- chemical analysis of the dehydrated flavoured chicken shreds to estimate the storage life at ambient temperature was performed at ten day intervals.

pH :

The pH of fresh and stored dehydrated low sodium chicken strips was determined by the method of Trout *et al*. (1992). Five grams of sample was homogenized with 50 ml of distilled water in a laboratory blender. The pH of suspension was recorded with the help of digital meat pH meter (model- HI 99163 portable water proof meat pH meter from HANNA).

Water activity :

Water activity (a_w) was measured using a Lab-Swift water activity meter by Novasina, Switzerland at room temperature. Initially water activity meter was calibrated with the standards (SAL-T) and then as shown in Fig. 3, test material was filled in the sample cup and kept for analysis.

Thiobarbituric acid value :

TBA number of fresh and stored low sodium dehydrated chicken strips was determined as per the method described by Strange *et al*. (1977) with slight modifications. Trichloroacetic acid (TCA) extract was prepared by blending 20 g of sample with 50 ml of precooled 20 per cent TCA solution for two min. After homogenisation, the contents were transferred to a beaker by rinsing with 50 ml cold distilled water, mixed and filtered through whatman's filter paper No.1. Five ml aliquot of TCA extract was mixed with 5 ml of 0.01M 2-TBA reagent in a test tube. The test tubes were kept in a water bath at 100°C for 30 min. After cooling the tubes in running water for about 10 min, the absorbance (A) at 532 nm was measured in spectrophotometer (Model no. EQ 820 with wavelength range of 350-950 nm, INDIA).

Tyrosine value :

The procedure described by Strange *et al*. (1977) was used with slight modifications. TCA extract of 2.5 ml was taken and mixed with equal amount of distilled water. The mixture was blended with addition of 10 ml of 0.5N NaOH to which 3 ml of diluted Folin and Ciacaltieus reagent was added. The mixture after shaking was kept in dark at room temperature for 30 min for colour development. The optical density was measured at 730 nm using Spectrophotometer. Tyrosine value was calculated as mg tyrosine per 100 g of sample by referring to a standard graph, which was prepared as per the procedure described by Pearson (1968).

Sodium estimation (colourimetric end point test) :

Sodium estimation of finished products was estimated by Autoanalyser – prietest touch (Rabonik, India) at the Department of Veterinary Physiology Parel, Mumbai -400012.

Microbiological analysis :

Total plate count on 0^{th}, 10^{th}, 20^{th} and 30^{th} days of storage and Coliform and *Salmonella* count at the end of storage life were determined following the standard method of APHA (1992).

Total plate count (TPC) :

Plate count agar (23.5 g) was suspended in one liter distilled water, boiled to dissolve the medium completely and pH was adjusted to 7.0 $\pm$ 0.2. It was then sterilized by autoclaving at 15 lbs pressure for 15 min.

One ml of inoculums from selected dilution was transferred into a sterile empty petriplate. About 20-25 ml of molten media at 45°C was poured in each petriplate and was mixed by rotating the plates five times each in clockwise and anticlockwise directions. The plates were allowed to set and incubated at 37 $\pm$ 1°C for 24 hours. Plates showing 30-300 colonies were selected and counted for calculating the TPC and expressed as $\log_{10}$ cfu/g.

Coliform count :

41.5 g of Violet Red Bile Agar (VRBA) was suspended in one liter of distilled water and boiled to dissolve the medium completely. Final pH of the medium was adjusted to 7.4 ± 0.2. Precaution was

taken not to autoclave the medium. One ml of suitable dilutions were placed in sterile pertidishes and overlaid with molten agar. After solidification, the plates were incubated at 37°C for 24 hours. The number of red or purple colonies of 0.5 mm in diameter were counted and expressed as $\log_{10}$ cfu/g of sample.

Salmonella count :

For detection of *Salmonella*, pre-enrichment was done by suspending 25 g of sample in 225 ml buffered peptone water (Merck) followed by incubation at 37°C for 16 to 20 hours; Selective enrichment was done by transferring 0.1 ml of pre-enrichment culture in ten ml Rappaport-Vassiliadis broth (RVS broth) followed by incubation at 42°C for 24 hours. After incubation the samples were streaked on BGSA agar and incubated at 37°C for 24 hours. Pink colonies appearing on the plates were counted and expressed as $\log_{10}$ cfu/g.

Sensory evaluation :

On the zero day of analysis, the low sodium dehydrated chicken strips were made into clear soup by boiling 20 g of each sample (T_1, T_2 ,T_3 and control) with 400 ml drinking water for seven minutes. The freshly prepared soups were organolepticaly evaluated by a panel of five judges. The panel was comprised of trained academic staff of the institute. The soups were judged for various sensory attributes *viz.*, appearance, flavour, texture and overall acceptability using a nine point descriptive scale (Keeton, 1983). The score of five judges was averaged and recorded as mean value for sensory score. The judges were also requested to give their critical comments for the products.

Economics of low sodium chicken strips :

The economics of the low sodium chicken strips prepared from spent hen meat was worked out on the basis of present cost of various ingredients and cost of other processing parameters.

Statistical analysis :

The data obtained during the experiment was analyzed by Analysis of Variance following standard procedure (Snedecor and Cochran, 1989). The observations of storage study were analyzed using ANOVA: Two Factor with Replication and observations for all other parameters were analyzed using ANOVA: Single Factor.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Composition of low sodium chicken strips :

Freshly obtained low sodium chicken strips were subjected to the analysis for various parameters at 0th day and the results obtained are tabulated in Table 1. It is observed that the moisture content of LSCS were 8.71±0.18, 9.36±0.39, 11.5±0.28 and 8.91±0.26, respectively for T_1, T_2, T_3 and control sample. There was no significant difference in the moisture content of the treated sample from that of control. The fat content of LSCS was 3.36±0.42, 3.80±0.49, 3.66±0.42 and 3.60±0.20, respectively for T_1, T_2, T_3 and control samples. The protein content of LSCS was 79.49±0.86, 81.83±0.91, 80.42±0.45 and 79.65±0.96 for T_1, T_2, T_3 and control, respectively. There was no significant difference in fat and protein content in the treated samples compare to control sample.

On analysis of sodium content of LSCS, value observed were 17.00±0.47, 17.88±0.22, 19.98±0.29 and 22.98±0.36 (mmol/lit), respectively for T_1, T_2, T_3 and control samples. The results show that with the per cent replacement of NaCl with other salts lead to proportionate decrease in the sodium content from T_3 to T_1. From the above results it appears that a 50 per cent partial substitution of NaCl by KCl seems to be the best alternative to reduce sodium content in meat products. Similar reports were observed by Armenteros *et al.* (2009) in salted dry cured loins.

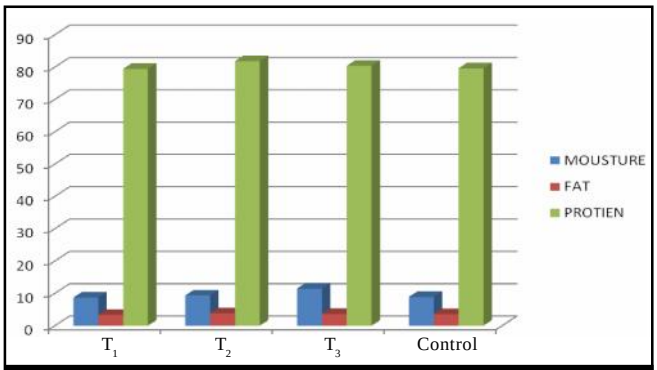

Fig. 1 : Composition of LSCS

Table 1 : Composition of low sodium chicken strips

Treatments	Moisture%	Fat%	Protein%	Sodium (mmol/lit)	a_W	p^H
T_1	8.71±0.18	3.36 ±042	79.49±0.86	17.00^a ±0.47	0.58 ±0.01	5.97 ±0.14
T_2	9.36±039	3.83±0.49	81.83±0.91	17.88^a±0.22	0.60±0.01	5.87±0.01
T_3	11.5±0.28	3.66±0.42	80.42±0.45	19.98^b±0.29	0.61±0.01	5.85±0.01
Control	8.91±0.26	3.60±0.20	79.65±0.96	22.98^c±0.36	0.55±0.01	5.86±0.06
F value	10.24	0.29	0.94	58.92	1.55	0.27
Significance	NS	NS	NS	S	NS	NS

Values reported are the mean values from four trials ± S.E. NS: non-significant a b c d superscripts are significantly different (P<0.01). CD value: 1.06

Rehydration studies of low sodium chicken strips :

Parameter used for evaluating the rehydration property of low sodium chicken strips was change in the rehydration ratio of low sodium chicken strips during storage. The results obtained are discussed hereunder.

Rehydration ratio :

The changes in the rehydration ratio of LSCS during storage, the average rehydration ratio for T_1, T_2, T_3 and control were 1.54±0.02, 1.45±0.01, 1.45±0.01 and 1.52±0.03, respectively, at 0^{th} day decreased slightly to 1.43±0.03, 1.37±0.02, 1.36±0.01 and 1.46±0.01, respectively on 30^{th} day. Meat products dehydrated by hot air drying are known to have poor rehydration ratio (Shank and Park, 1966 and Lawrie, 1985). The rehydration ratio exhibited by all the treatments in low sodium chicken strips (T_3, T_1, T_2 and C) in the present investigation is comparable to the values reported for dehydrated flavoured chicken shreds by Sumin (2012) which was in the range of 1.66±0.06 to 1.7±0.03 (Table 2 and Fig. 2).

Physico-chemical changes in low sodium chicken strips during storage :

The shelf-life of a product is determined by two kinds of deteriorations; physic-chemical and micro-biological. The physicochemical changes in the low sodium chicken strips were monitored by analyzing changes in water activity, pH, TBARS value and tyrosine value at an interval of 10 days during storage. The results obtained are discussed hereunder.

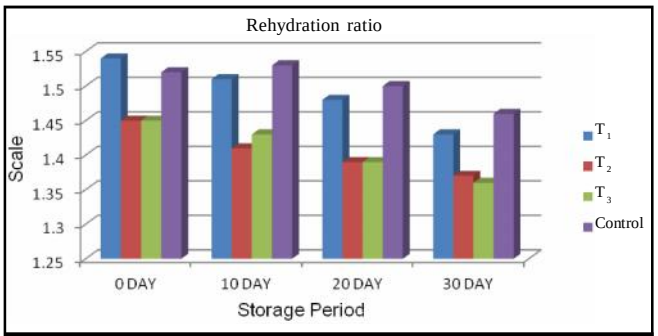

Fig. 2 : Changes in the rehydration ratio of LSCS

Water activity :

The changes in the water activity values for LSCS during storage are presented in Table 3 and Fig.3.

The average water activity value for all the treatments at

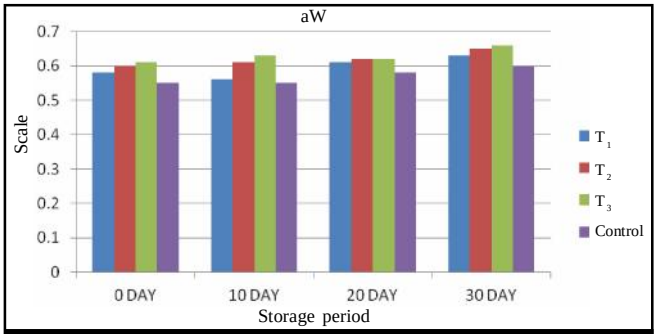

Fig. 3 : Water activity

Table 2 : Rehydration ratios of LSCS observed during storage

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	1.54±0.02	1.51±0.02	1.48±0.03	1.43±0.03	1.49±0.02
T_2	1.45±0.01	1.41±0.01	1.39±0.01	1.37±0.02	1.40±0.01
T_3	1.45±0.01	1.43±0.01	1.39±0.01	1.36±0.01	1.41±0.01
Control	1.52±0.03	1.53±0.02	1.50±0.01	1.46±0.01	1.50±0.02
Treatment mean	1.49±0.02	1.47±0.01	1.44±0.01	1.41±0.02	
			S.E.		C.D.
Treatment			0.01		0.03
Days			0.01		0.03

Values are averages of 4 replications

Table 3 : Water activity (aW) values of LSCS observed during storage

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	0.58±0.01	0.56±0.01	0.61±0.01	0.63±0.01	0.59±0.01
T_2	0.60±0.01	0.61±0.01	0.62±0.01	0.65±0.01	0.62±0.01
T_3	0.61±0.01	0.63±0.01	0.62±0.01	0.66±0.01	0.63±0.01
Control	0.55±0.01	0.55±0.01	0.58±0.01	0.60±0.01	0.57±0.01
Treatment mean	0.58 ±0.01	0.59±0.01	0.61±0.01	0.63±0.01	
			S.E.		C.D.
Treatment			0.003		0.01
Days			0.003		0.01

Values are averages of four replications

0th day was 0.58±0.01 which increased to 0.63±0.01 at the end of 30th days of storage. The average water activity values for T_1, T_2, T_3 and C were 0.59±0.01, 0.62±0.01and 0.63±0.01 and 0.57±0.01, respectively. There was no significant effect of replacement of salts on the water activity of LSCS compare to control during storage period. The values reported for water activity are well below the average value reported to be safe (0.80) for consumption of dried products. A similar trend of increase in the water activity was observed in dehydrated flavoured chicken shreds by Sumin (2012).

pH :

The changes in pH values during storage of low LSCS are depicted in the Table 4 and Fig. 4.

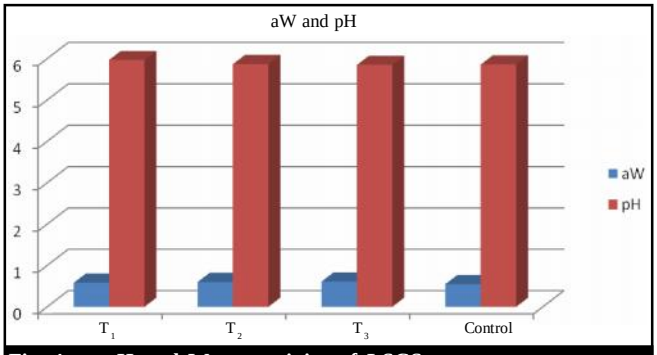

Fig. 4 : pH and Water activity of LSCS

The average pH value for all the T_1 at 0th day was 5.97±0.01 which increased to 6.11±0.05. at the end of 30th days of storage. The average water activity values for T_1, T_2, T_3 and C were 0.59±0.01, 0.62±0.01 and 0.63±0.01 and 0.57±0.01, respectively The average pH value for T_1 at 0th day was 5.97±0.01 which increased to 6.11±0.05 on 30th day. The value for T_2 at 0th 5.87±0.01 to a maximum of 6.01±0.01 at 30th day. The average pH value for T_3 during storage was 5.94±0.13, which varied from a minimum of 5.85±0.13 on 0th day to a maximum of 6.01±0.12 on 30th day. The average pH value for control was 6.00±0.06, which ranged between 5.86±0.10 and 6.09±0.06. Though the values on pH changes exhibited an non-significant change in the overall storage period, it is clear that as the storage period advanced, there was slight increase in the pH value in all the treated samples as well as in control samples, this could be ascribed to the proteolysis, which is reflected by the tyrosine values. A similar trend of increase in the pH was observed in dehydrated flavoured chicken shreds by Sumin (2012).

Tyrosine value :

The changes in tyrosine value of LSCS during storage are highlighted in Table 5 and Fig. 5 The average value during storage period for T_1, T_2, T_3 and C were 3.9±0.15, 4.92±0.17, 4.78±0.20 and 5.25±0.14, respectively. During storage the tyrosine value for T_1 was 2.72±0.17 on 0th day, which changed to 5.86±0.13 on 30th day. The value for T_2 was 2.6±0.10 on 0th day which changed to 6.05±0.24 on 30th day. The values for T_3

Table 4 : pH values of low LSCS observed during storage

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	5.97±0.01	6.06±0.01	6.10±0.01	6.11±0.05	6.06±0.02
T_2	5.87±0.01	5.91±0.01	5.97±0.01	6.01±0.01	5.94±0.01
T_3	5.85±0.13	5.92±0.14	5.97±0.17	6.01±0.12	5.94±0.13
Control	5.86±0.10	6.05±0.03	6.00±0.05	6.09±0.06	6.00±0.06
Treatment mean	5.89±0.08	5.98±0.05	6.01±0.06	6.06±0.07	
		S.E.		CD	
Treatment		0.03		0.08	
Days		0.03		0.08	

Values are averages of four replications

Table 5 : Tyrosine values (mg/100g) of LSCS observed during storage

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	2.72±0.17	3.05±0.26	4.24±0.20	5.86±0.13	3.9±0.15
T_2	2.6±0.10	3.72±0.18	4.99±0.21	6.05±0.24	4.92±0.17
T_3	3.26±0.12	4.25±0.21	5.31±0.23	6.32±0.24	4.78±0.20
Control	4.68±0.14	4.87±0.18	5.22±0.15	6.25±0.13	5.25±0.14
Treatment mean	3.20±0.12	4.25±0.20	5.31±0.18	4.78±0.20	
		S.E.		CD	
Treatment		0. 39		1.13	
Days		0.39		1.13	

Values are averages of four replications

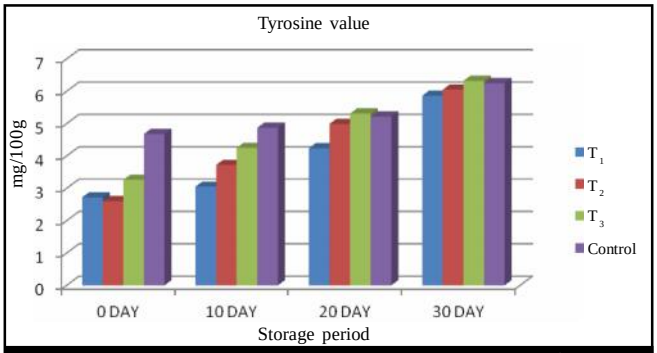

Fig. 5 : Changes in tyrosine value during storage of LSCS

was 3.26±0.12 on 0th day, which changed to 6.32±0.24 on 30th days, for control it was 4.68±0.14 on 0th day, which increased to 6.25±0.13 on 30th day. The tyrosine value is an indication of proteolysis. There was consistent trend of increase in tyrosine value during entire storage period. The values observed in the present study for the tyrosine value are lower than values reported by Santosh Kumar *et al*. (2012) for fresh chicken. It is clear that as the storage period advanced, there was slight increase in the tyrosine value, this could be ascribed to further proteolysis during storage (Kowale *et al*., 2008).

TBARS value :

The changes in the TBARS values of LSCS during storage are highlighted in the Table 6 and Fig. 6. The average value for T_1, T_2, T_3 and C were 1.59±0.15, 1.65±0.12, 1.77±0.15 and 1.52±0.13, respectively. During storage the TBARS value for T_1 was 1.18±0.17 on 0th day, which increased to 2.00±0.14 on 30th day. The value for T_2 was 1.14±0.08 on 0th day, which changed to 2.17±0. 0.12 on 30th day. The values for T_3 was 1.21±0.12 on 0th day, which changed to 2.27±0.15 on 30th day and for control it was 1.09±0.14 on 0th day, which increased to 1.96±0.13 on 30th days. The TBARS values of LSCS exhibited an increasing trend throughout the storage life for all treatments There was no significant difference either between treatments or during the storage period. A similar increasing trend was reported by Modi *et al*. (2007) for dehydrated chicken kebab mix and by Li *et al.* (1996) for tocopherol supplemented freeze dried chicken meat powder during storage, which indicates a gradual development of oxidative rancidity. A similar trend of increase in the TBARS values was observed in dehydrated

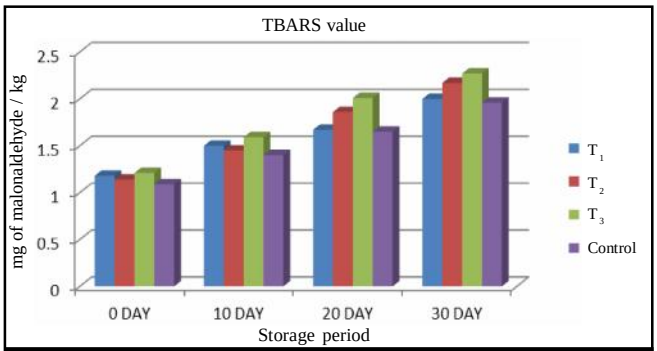

Fig. 6 : Changes in TBARS value during storage of LSCS

Table 6 : TBARS values (mg of malonaldehyde / kg) of LSCS observed during storage

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	1.18±0.17	1.50±0.22	1.67±0.17	2.00±0.14	1.59 ±0.15
T_2	1.14±0.08	1.45±0.15	1.86±0.18	2.17±0.21	1.65 ±0.12
T_3	1.21±0.12	1.59±0.18	2.01±0.23	2.27±0.22	1.77 ±0.15
Control	1.09±0.14	1.40±0.14	1.65±0.13	1.96±0.13	1.52 ±0.13
Treatment mean	1.15 ±0.13	1.49±0.15	1.80±0.18	2.10 ±0.17	
		S.E.		C.D.	
Treatment		0.09		0.27	
Days		0.09		0.27	

Values are averages of four replications

Table 7 : TPC for LSCS during storage (x10³cfu/g)

Treatments	0 days	10 days	20 days	30 days	Storage mean
T_1	4.85±0.38	5.42±0.10	5.82±0.2	7.05±0.01	5.78±0.12
T_2	3.71±0.31	5.49±0.08	5.81±0.03	7.09±0.01	5.52±0.11
T_3	4.90±0.44	5.86±0.34	5.86±0.01	6.82±0.01	5.89±0.19
Control	3.47±0.32	5.11±0.11	5.77±0.02	7.06±0.25	5.35±0.15
Treatment mean	4.27^{a}±0.31	5.47^{b}±0.16	5.72^{b}±0.02	6.86^{c}±0.05	
		S.E.		C.D.	
Treatment		0.21		0.81	
Days		0.21		0.81	

Values are averages of 4 replications. Means in the same row or column with different superscripts are significantly different (P<0.01). CD value: 0.81

flavoured chicken shreds by Sumin (2012). All the values obtained in the present study are well within the range reported by Modi *et al*. (2007) for dehydrated chicken kebab mix.

Microbiological status of LSCS during storage :

The low LSCS were evaluated micro-biologically by means of Total Plate Count (TPC) at ten days intervals during storage and *Salmonella* and Coliform count at the end of storage study. The results obtained for TPC are depicted in Table 7and Fig. 7.

The total plate count (x10³cfu/g) for T_1 during storage increased from a minimum count of 4.85±0.38 on 0th day to a maximum count of 7.05±0.01 on 30th day with an average of 5.78±0.12. TPC for T_2 during storage life increased from a minimum count of 3.71±0.31 on 0th day to a maximum count of 7.09±0.01 on 30th day with an average of 5.52±0.11. The minimum value and maximum values for T_3 were 4.90±0.44 and 6.82±0.01 on 0th and 30th days, respectively, which averaged to 5.89±0.19. The average TPC value for control was 5.35±0.15 which ranged between a minimum of 3.47±0.32 and a maximum of 7.06±0.25 on 0th and 30th days, respectively.

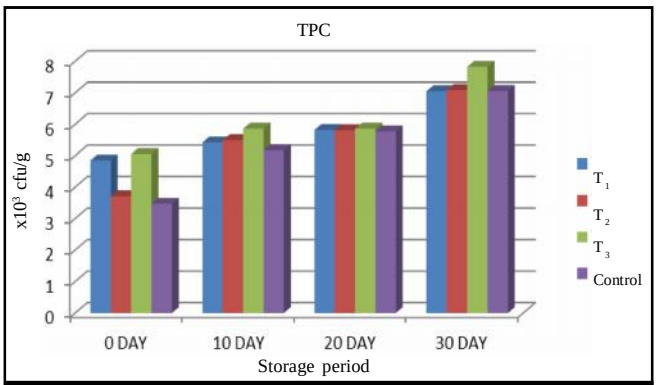

Fig. 7 : TPC for LSCS during storage (x10³cfu/g)

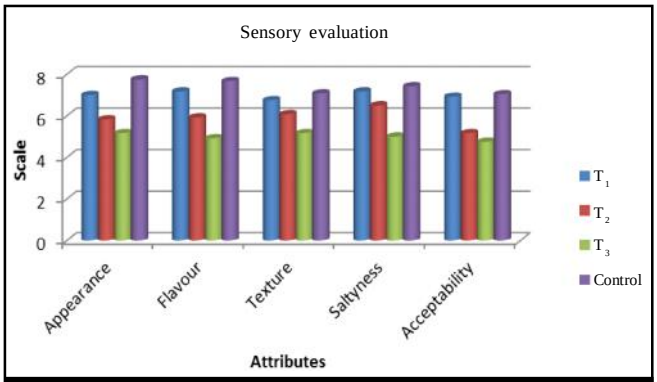

Fig. 8 : Sensory evaluation of LSCS

Table 8 : Sensory evaluation scores for LSCS

Treatments	Appearance	Flavour	Texture	Saltiness	Acceptability
T_1	7.00^{b}±0.27	7.17^{a}±0.20	6.75^{a}±0.21	7.17^{a}±0.20	6.92^{b}±0.22
T_2	5.83^{c}±0.27	5.92^{b}±0.22	6.08^{b}±0.22	6.50^{b}±0.19	5.17^{b}±0.27
T_3	5.17^{d}±0.20	4.92^{c}±0.19	5.17^{c}±0.20	5.00^{b}±0.24	4.75^{c}±0.17
Control	7.75^{a}±0.13	7.67^{a}±0.14	7.08^{a}±0.19	7.42^{a}±0.19	7.04^{a}±0.17
F value	25.60	40.36	15.66	26.36	29.34
CD	0.63	0.54	0.59	0.58	0.60

*a b c superscript in the column are significantly different at the level of ($p<0.01$)

Table 9 : Cost of one kg spent hen LSCS

Sr. No.	Ingredients	Rate/kg (Rs.)	T_1		T_2		T_2 control			
			Qty. (g)	Cost (Rs.)	Qty. (g)	Cost (Rs.)	Qty. (g)	Cost (Rs.)	Qty. (g)	Cost (Rs.)
1.	Spent hen meat	Rs.130	500	65	500	65	500	65	500	65
2.	NaCl	Rs. 222	25	5.55	30	6.66	35	7.77	50	11.10
3.	KCl	Rs. 388	25	9.70						
4.	$MgCl_2$	Rs. 548			20	10.96				
5.	$CaCl_2$	Rs. 588					15	8.82		
6.	Drying cost per hour (Avg. 5 hours/batch)	Rs. 5	25		25		25		25	
7.	After drying (Wt .in grams)		155		160		155.55		143.40	
8.	Yield (%)		31%		32%		31.11%		28.60%	
9.	Cost of spent hen meat LSCS		105.25		107.62		106.59		101.10	
10.	Actual cost of processing of LSCS (Rs./kg)		679.03		672.62		685.24		705.02	
11.	Round off cost (Rs./kg)		679		673		685		705	

Such an increasing trend is well in accordance with previous findings (Kharb *et al*., 2008 and Adeyinka *et al*., 2011). The treatments did not have any significant influence on the total plate counts. However, storage period had statistically significant effect ($P<0.01$) on total plate counts of low sodium chicken strips as it exhibited a significant increase on 30th day of storage. All the TPC values observed in the present study were well below the limit for soup powders (40×10^3cfu/g) as per Prevention of Food Adulteration Rules,1956 (Prakash and Dwivedi, 2012). All the treatments under study were subjected to analysis for Coliform and *Salmonella* count. However, none of the samples was positive for *Salmonella* and Coliform.

Sensory evaluation of LSCS :

Fresh LSCS were prepared in the form of a clear soup and evaluated on 0th day by a semi trained sensory panel consisting of the academic staff of the institution. The low sodium chicken strips were evaluated for parameters such as appearance, flavour, texture and overall acceptability on a nine point descriptive scale. The sensory scores for all three treatments are tabulated in Table 8 and Fig. 8.

It is evident that the overall acceptability for LSCS among the treated samples compare to control was better for T_1 *i.e.* the chicken strips prepared with 50 per cent replacement of NaCl with KCl followed by T_2 and T_3. Flavour, texture and saltiness of the LSCS prepared using 50 per cent of replacement of NaCl with KCl were comparable with LSCS prepared using 100 per cent NaCl. The LSCS prepared with 30 per cent replacement of NaCl with 30 per cent of $CaCl_2$ were almost unacceptable in all the sensory attributes. The LSCS prepared with 40 per cent replacement of NaCl with 40 per cent of $MgCl_2$ were upto the acceptable level in all the sensory attributes except appearance. Overall results indicated that acceptable quality LSCS could be manufactured with 50 per cent replacement of NaCl with KCl.

It is also evident that appearance was significantly ($P<0.01$) better for control, compared to T_1, T_2 and T_3. However T_1 is comparatively nearer in appearance to control. The low sodium chicken strips treated with KCl (T_1) was significantly ($P<0.01$) better in flavour, texture, saltiness and acceptability than low sodium chicken strips treated with either $MgCl_2$ (T_2) or $CaCl_2$ (T_3). Moreover, differences in flavour, texture, saltiness and acceptability among T_1 and the control were statistically non-significant. No cited literature is available on the sensory attributes of such types of products. Among the three treatments, judges accepted significantly the chicken strips treated with with KCl (T_1) over chicken strips treated with $MgCl_2$ (T_2) or $CaCl_2$ (T_3).

Economics of LSCS :

There are varieties of dehydrated meat products throughout the world, which are famous with their typical manufacturing processes. The traditional dehydrated meat products are very famous at the village level in north eastern India, which are manufactured by salting and sun drying of meat. Use of spent hen meat for manufacturing such dehydrated products with low sodium content thought to be of value addition of spent hen meat. Low sodium meat products are very popular among health conscious people. Looking at the popularity of this food, it was also decided to work out the economics of the low sodium chicken strips in the present study. For the purpose a cost of spent hen meat was worked out by considering the existing market prices.

Average cost of one kg spent hen meat was Rs. 130.00 by considering the present market prices. While calculating the cost of low sodium chicken strips, cost of various processed parameters as depicted in Table 9 were considered for calculation of cost of one kg finished products.

From the Table 9 it is clear that the cost of spent hen meat low sodium chicken strips after considering all the parameters and after drying was Rs. 105.25, Rs. 107.62, Rs. 106.59 and Rs. 101.10, respectively, for T_1, T_2, T_3 and control. The average yield observed in the present study for low sodium chicken strips after drying was in the range of 29-32 per cent for all the treatments. Thus, the cost of one kg dried low sodium chicken strips became Rs. 679, Rs. 673, Rs. 685 and Rs. 705, respectively for T_1, T_2, T_3 and control. While some of the dehydrated products, dried chicken chips freeze dried shrimp meat and dried chicken jerky the cost of product was recorded (Rs. 550-1500/ kg) from market. It was found that low sodium chicken strips (LSCS) developed has lower cost as compared to market rates of dehydrated meat products.

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