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Effect of modified atmospheric packaging on shelf-life of *Cham-cham*

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SUMMARY :

The present study was carried out to evaluate the shelf-life of *Cham-Cham* using modified atmospheric packaging (MAP). *Cham-Cham* stored under refrigeration temperature (7 ± 2^0C) in modified atmospheric condition showed significantly higher shelf-life than the *Cham-Cham* stored at same temperature in normal packaging condition. The compositional attributes such as fat, protein, total carbohydrate and ash of *Cham-Cham* increased significantly where as moisture was significantly decreased up on storage at 7 ± 2^0C. The acidity and soluble nitrogen content where non-significantly increased. However, pH of *Cham-Cham* decreased significantly on storage at 7 ± 2^0C. FFA and HMF content of *Cham-Cham* increased significantly when *Cham-Cham* stored at 7 ± 2^0C. The packages were found to have a significant increased in the hardness, chewiness and cohesiveness. However, significant decreased in the adhesiveness and springiness values of *Cham-Cham* were found at 7 ± 2^0C storage temperature. However stiffness of *Cham-Cham* increased non-significantly at 7 ± 2^0C. The flavour, body and texture, colour and appearance and overall acceptability scores of *Cham-Cham* declined significantly as storage period progressed. Hence, the shelf-life of *Cham-Cham* extended up to 28 days in MAP as compare to normal packaging shows up to 14 days. It also shows that the use of CO_2 was superior to N_2 in MAP.

KEY WORDS : Modified atmospheric packaging, *Cham-Cham*, Shelf-life, FFA, HMF

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The shelf-life of perishable foods as milk products, meat, poultry, fish, fruits and vegetables is limited in the presence of normal air by two principle factors *i.e.* the chemical effect of atmospheric oxygen and the growth of aerobic spoilage micro-organisms. Recently the traditional dairy products and sweets are gaining extreme popularity not only in India but also in the world thereby finding tremendous consumer base (Pal and Raju, 2007).

Cham-Cham originated in eastern parts of India (especially in West Bengal). It is a heat-acid coagulated product sweet prepared from *Chhana* with a firm body

and close knit texture. The product resemble to *Rasogolla*, in many aspects. *Cham-Cham* as is produced and marketed has a limited shelf-life of nearly 3-4 days at room temperature and is generally consumed fresh. For making it popular outside the traditional manufacturing region, there is a need to have a higher shelf-life of the product. The shelf-life of a heat and acid coagulated dairy product is generally determined by the conditions maintained post-production because such product produced hygenically and hence, get spoiled due to post-production contamination.

Packaging industry is an important sector, adding value to the various manufacturing sectors including agriculture and fast moving consumer goods segments (Anonymous, 2013). Consumers want to be assured that the packaging is important in protecting the quality, freshness and safety of foods. To provide this assurance and to help the performance of the packaging, innovative active and MAP concepts are being developed.

In MAP the main gases used are nitrogen (N_2) and carbon dioxide (CO_2). N_2 is an inert gas which has been used as packaging filler for many years to prevent pack collapse. N_2 is used as a filler gas because of its low solubility in water and lipid compared with that of CO_2. CO_2 is the major anti-microbial factor of MAP. Microbial growth is reduced at high concentrations of CO_2 in a variety of products and this effect increases as storage temperature decrease (Phillips, 1996).

Therefore, present experiment is planned with a view to study the effects of flushing of gases in packaging system which are used and available for packaging of similar dairy and food products in the commercial practice. Also when advanced technology such as inert gas e.g. N_2 and CO_2 packaging are employed, it is likely to extend the shelf-life of such dairy product *i.e. Cham-Cham* by preventing the oxidative deterioration of the product.

EXPERIMENTAL METHODS

The present investigation was carried out in the Department of Dairy Technology, S.M.C. College of Dairy Science, Anand in the year 2012-14. Experimental *Cham-Cham* was prepared by the method suggested by Sengar (2013) except that the layer of khoa placed between the pieces of *Cham-Cham*. Three replications were carried out for study. The average chemical composition of *Cham-Cham* used for experiment and the values are average of three replications. Moisture, fat, protein, ash content of *Cham-Cham* were 39.15±0.05, 12.84±0.05, 11.54±0.02, 1.28±0.01 per cent, respectively. Total carbohydrate content was calculated on the by difference basis and that was 35.19±0.03 per cent. The acidity, pH, water activity, FFA, HMF, soluble nitrogen of experimental *Cham-Cham* were 0.345±0.004 % LA, 6.33±0.02, 0.965±0.003, 0.487±0.010 µeq/g, 1.325±0.004 µmole/100g, 0.011±0.001 %, respectively. It can be seen that hardness, chewiness, cohesiveness, adhesiveness, stiffness, springiness of experimental *Cham-Cham* were 58.13±1.98 N, 145.58±3.11 Nmm, 0.551±0.002, 1.15±0.02 Nmm, 37.90±0.39 N/mm, 10.39±0.06 mm, respectively. It was observed that product had standard plate count 2.84±0.10 cfu/g (log transformed), whereas yeast and mold and coliform count was found absent. The flavour, body and texture, colour and appearance and overall acceptability of experimental *Cham-Cham* were 8.42±0.03, 8.31±0.07, 8.38±0.07, 8.36±0.10, respectively.

The Pet-Polyester/Polyfilm pouches (~ 85 µ) were procured from Vidya Dairy, Anand, whereas the PVC trays were procured from Industrial Plastic Forming Co., Mumbai and used as a packaging material. *Cham-Cham* was transferred under hygienic conditions to transparent PVC tray packages and these trays were inserted into pouches made of Pet-Polyester/Polyfilm pouches. The pouches used were pre-sterilized by UV radiation in a chamber to avoid contamination through packages. Immediately before the heat sealing of the filled packages to make an airtight joint, it was flushed with N_2 gas or CO_2 gas. The present study involves the assessment of fresh and stored *Cham-Cham* for compositional, physico-chemical, textural, microbiological and sensory characteristics at regular interval of storage. The samples stored at refrigeration temperature (7 ± 2^0C) were evaluated at regular interval of 7 days. The humidity of the atmosphere was maintained to 65 per cent RH.

Analysis of sample :

Samples were determined for moisture content by standard procedure using Mojonnier Milk Tester Model-D as per the process prescribed in the Laboratory Manual (1959). Fat extraction of sample was determined as per the procedure described below from IS: 2311-1963. Total nitrogen/protein of sample was determined by Semi-microkjeldahl method (IS: 1479-Part- II, 1961), using Kjel-plus digestion system (Model-KPS 006L) and Kjel-plus

semi-automatic distillation system (Model-Distil M). Ash content of all the samples was determined by procedure described in BIS (IS: 1547-1985).

Head Space O_2 of sample package was measured using Check Point Handheld Gas Analyzer (M/S PBI Dansensor, Denmark). Titratable Acidity of all the samples was determined by procedure described in BIS (IS: 1166 and 1968) for condensed milk. The pH of sample was measured using Systronic digital pH meter, model 335. The method described by O'Keeffe *et al.* (1976) for Cheddar cheese was used. The water activity of *Cham-Cham* samples, tempered at 25^0C temperature, was measured using Rotromic Hygroskop Model: Hygrolab-3 (M/s. Rotronic ag, Switzerland) connected to a sensing element (AW-DIO) with a measuring range of 0-100 per cent Relative Humidity (RH). The soluble nitrogen content of *Cham-Cham* sample was determined by the procedure outlined by Kosikowski (1982). The method prescribed by Deeth *et al.* (1975) was used to estimate the FFA content of *Cham-Cham*. The quantitative method presented by Keeney and Bassette (1959) for quantifying HMF (µ moles / 100g) was used for the sample of *Cham-Cham.*

Textural properties were determined using a Universal Testing Instrument, Model-LRX Plus (Lloyd Instruments, England) equipped with a 0-500 kg cell. The packages were served to a panel of judges for evaluation of sensory quality during storage at regular interval. The *Cham-Cham* samples were evaluated using a 9 point hedonic scale. All the *Cham-Cham* samples were drawn aseptically and analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and mold count as described in BIS (IS: 5404, 1969).

Statistical analysis :

The mean values generated from the analysis of samples of *Cham-Cham*, obtained in three replications were subjected analysis using Factorial Completely Randomized Design (FCRD) was adopted as given by Steel and Torrie (1980).

EXPERIMENTAL FINDINGS AND ANALYSIS

The *Cham-Cham* stored at 7 ± 2^0C was analyzed at an interval of 7 days and up to 28 days and thereafter the product was found unacceptable because of the visible mold growth in the product. The control sample was found unacceptable at 14 days of storage at same temperature.

Storage related changes in *Cham-Cham* packed in selected modified atmospheric packaging system :

Changes in compositional attributes of Cham-Cham:

The compositional attributes of *Cham-Cham* is important as it affect on consistency and sensory characteristics. The moisture content also plays a significant role on the microbial quality of the product during storage as far as bacterial activity specially yeast and mold growth and hence, directly influences the shelf-life of the product to a greater extent.

The values depicted in Table 1 revealed that as the storage period progress the sample stored at 7 ± 2^0C were having significant ($P<0.05$) effect on the moisture, fat, protein, total carbohydrate and ash content of the *Cham-Cham* stored in both package containing N_2 and CO_2. Whereas, the compositional values of the stored *Cham-Cham* packed in N_2 and CO_2 package were not affected significantly ($P<0.05$) either by the package or the interaction effect of package and period of storage. The moisture content of *Cham-Cham* was decrease significantly as the storage period advance in the both package contain N_2 and CO_2 at the storage temperature of 7 ± 2^0C. However, the fat, protein, total carbohydrate and ash content of the sample were increase non-significantly as the storage period progress at the same storage temperature. The decreased in moisture content during refrigerated storage might be due to evaporation of water at low temperature (7 ± 2^0C) and surface evaporation (Sharma *et al*., 2003). There was also reduction in moisture content and increase of other total solids of *Cham-Cham* during storage at 30 ± 2^0C and 7 ± 2^0C (Sengar, 2013). Tiwari (2013) reported that increased of fat, total protein, total carbohydrate and ash content during storage of *Burfi* at 37 ± 2^0C and 7 ± 2^0C. The increased in total protein, total carbohydrate and ash content of *Cham-Cham* might be due to the loss of moisture, resulted into increased of total solids.

Changes in physico-chemical properties of Cham-Cham :

Cham-Cham samples were analyzed to know the extent of their presence in samples because these are the properties which decide the quality of the product and its shelf-life. Thus, the results obtained might be useful in giving some idea regarding the quality aspects as well

as to have their possible correction with packages, storage period and storage temperature.

The stored samples of *Cham-Cham* were studied for physico-chemical properties like acidity, pH, FFA, HMF, soluble nitrogen, water activity and head space O_2 to have an idea of effect of package and storage period on *Cham-Cham* at 7±2^{0}C (Table 2).

During storage of *Cham-Cham* as the storage period

Table 1 : Effect of storage period at refrigeration temperature (7±2^{0}C) temperature on compositional attributes of *Cham-Cham* packed in different packaging system

Parameter	Packages	Storage period				
		0	7	14	21	28
Moisture	N_2	39.15±0.05	38.26±0.09	38.02±0.12	37.70±0.12	37.33±0.15
	CO_2	39.15±0.05	38.38±0.10	38.13±0.14	37.77±0.17	37.48±0.12
	Control	39.15±0.05	38.13±0.06	37.82±0.09	-	-
Fat	N_2	12.84±0.05	12.88±0.02	12.94±0.01	12.96±0.01	12.97±0.01
	CO_2	12.84±0.05	12.90±0.01	12.94±0.02	12.97±0.01	12.98±0.01
	Control	12.84±0.05	12.91±0.02	12.96±0.02	-	-
Protein	N_2	11.54±0.02	11.57±0.02	11.58±0.02	11.60±0.02	11.61±0.01
	CO_2	11.54±0.02	11.57±0.01	11.57±0.01	11.59±0.02	11.60±0.01
	Control	11.54±0.02	11.56±0.01	11.58±0.02	-	-
Carbohydrate	N_2	35.19±0.03	35.70±0.31	36.16±0.10	36.44±0.13	36.67±0.13
	CO_2	35.19±0.03	35.65±0.24	36.07±0.12	36.37±0.17	36.63±0.11
	Control	35.19±0.03	36.12±0.07	36.74±0.11	-	-
Ash	N_2	1.28±0.01	1.29±0.01	1.29±0.01	1.30±0.01	1.30±0.01
	CO_2	1.28±0.01	1.28±0.01	1.29±0.01	1.30±0.01	1.30±0.01
	Control	1.28±0.01	1.28±0.01	1.29±0.01	-	-

Table 2 : Effect of storage period at refrigeration temperature (7±2^{0}C) temperature on physico-chemical properties of *Cham-Cham* packed in different packaging system

Parameter	Packages	Storage period				
		0	7	14	21	28
Acidity	N_2	0.345±0.004	0.359±0.007	0.369±0.006	0.379±0.007	0.389±0.007
	CO_2	0.345±0.004	0.360±0.008	0.378±0.006	0.385±0.007	0.395±0.007
	Control	0.345±0.004	0.367±0.006	0.382±0.007	-	-
pH	N_2	6.33±0.02	6.31±0.03	6.27±0.03	6.22±0.02	6.21±0.02
	CO_2	6.33±0.02	6.29±0.02	6.25±0.02	6.21±0.02	6.19±0.02
	Control	6.33±0.02	6.30±0.02	6.23±0.02	-	-
Water Activity	N_2	0.965±0.003	0.949±0.004	0.940±0.006	0.933±0.005	0.926±0.006
	CO_2	0.965±0.003	0.953±0.004	0.942±0.005	0.935±0.006	0.928±0.005
	Control	0.965±0.003	0.945	0.932	-	-
FFA	N_2	0.487±0.010	0.515±0.005	0.529±0.006	0.543±0.006	0.559±0.008
(µeq / g)	CO_2	0.487±0.010	0.504±0.007	0.520±0.007	0.537±0.011	0.553±0.007
	Control	0.487±0.010	0.517±0.011	0.534±0.012	-	-
HMF	N_2	1.325±0.004	1.667±0.005	1.916±0.008	2.203±0.010	2.462±0.007
(µmole/100g)	CO_2	1.325±0.004	1.659±0.005	1.909±0.008	2.197±0.010	2.456±0.007
	Control	1.325±0.004	1.794±0.007	2.32±0.010	-	-
Soluble	N_2	0.011±0.001	0.016±0.001	0.022±0.001	0.024±0.001	0.027±0.001
Nitrogen (%)	CO_2	0.011±0.001	0.015±0.001	0.021±0.002	0.023±0.001	0.026±0.001
	Control	0.011±0.001	0.016±0.001	0.022±0.002	-	-
Head space O_2	N_2	3.83±0.03	3.16±0.02	3.05±0.04	2.94±0.05	2.77±0.05
(%)	CO_2	3.83±0.03	3.19±0.02	3.09±0.03	2.97±0.04	2.81±0.07
	Control	21.00±0.00	20.23±0.01	19.76±0.02	-	-

progress the sample stored were having significant increased in acidity, FFA, HMF and soluble nitrogen in both the package containing N_2 and CO_2 when stored at 7±2^{0}C. However, the pH, water activity and head space O_2 content of the sample were decreased significantly as the storage period progress in both the package containing N_2 and CO_2 when stored at 7±2^{0}C. The effect of the package and the interaction of package and period of storage had non-significant effect on acidity, pH, water activity, head space O_2 and soluble nitrogen content of *Cham-Cham* when stored at 7±2^{0}C. Whereas, the FFA and HMF content of the *Cham-Cham* having the significant effect on the package and non-significant effect on the interaction of the package and the storage period as the storage period advanced in both the package containing N_2 and CO_2 at the storage temperature of 7±2^{o}C.

Makhecha (2012) reported increased in acidity content of *Thabdi* stored at 30±2^{0}C and 7±2^{0}C in different packages. Prasad *et al.* (1989) found that the level of acidity developed may also be used to indicate the extent of microbial fermentation in product. The effect of storage period on acidity is a normal biochemical process in dairy products which might be the result of degradation of protein and lactose and also because of shift of minerals from serum to colloidal state. Kumar *et al*. (1997) reported a decrease in pH of *Peda* stored at 20^{0}C. Sengar (2013) critically studied and reported the increase in FFA content of *Cham-Cham* during storage at 30±2^{0}C and 7±2^{0}C. The observed results for change in soluble nitrogen content during storage are in accordance with the observations reported by Arora *et al.* (1995 and 1996) and Singh *et al.* (2007) for *Rasogolla*. The observations for HMF content are in line with the studies for microbial growth done by Ledenbach and Marshall (2009) and its relation to O_2 consumption as well as studies for the development of HMF and its relation to oxidative rancidity wherein O_2 is consumed (Gogus *et al.*, 2010). Raval (2013) noticed decreased in head space O_2 on storage of *Thabdi peda* at 37±2^{0}C and 20±2^{0}C packed in different packaging systems.

Changes in rheological properties of Cham-Cham:

Texture is a sensory property of foods that results from a versatile group of physical components. Instrumental texture profile analysis can be extremely useful in evaluating the textural quality of foods. The rheological properties of stored samples of *Cham-Cham* were measured in terms of hardness, chewiness, cohesiveness, adhesiveness, stiffness and springiness

Table 3 : Effect of storage period at refrigeration temperature (7±2^{0}C) temperature on rheological properties of *Cham-Cham* packed in different packaging system

Parameter	Packages	Storage period				
		0	7	14	21	28
Hardness (N)	N_2	58.13±1.98	74.66±5.59	89.18±4.65	103.94±4.46	125.27±6.46
	CO_2	58.13±1.98	73.34±5.30	86.81±5.00	101.08±6.31	122.61±9.23
	Control	58.13±1.98	78.62±5.42	93.47±6.24	-	-
Chewiness (Nmm)	N_2	145.58±3.11	273.02±6.30	383.26±7.58	466.29±7.72	526.94±3.52
	CO_2	145.58±3.11	277.02±6.86	387.49±6.87	470.27±4.21	532.41±8.25
	Control	145.58±3.11	291.45±6.47	453.64±7.71	-	-
Cohesiveness	N_2	0.551±0.002	0.567±0.008	0.577±0.006	0.593±0.005	0.612±0.002
	CO_2	0.551±0.002	0.564±0.007	0.574±0.005	0.590±0.003	0.605±0.003
	Control	0.551±0.002	0.569±0.007	0.582±0.006	-	-
Adhesiveness	N_2	1.15±0.02	0.91±0.05	0.72±0.04	0.53±0.05	0.29±0.04
(Nmm)	CO_2	1.15±0.02	0.95±0.03	0.74±0.05	0.58±0.03	0.32±0.05
	Control	1.15±0.02	0.87±0.05	0.66±0.06	-	-
Stiffness (N/mm)	N_2	37.90±0.39	46.01±1.02	51.69±2.44	57.07±2.76	64.54±2.56
	CO_2	37.90±0.39	46.16±2.85	53.70±2.53	60.69±3.68	67.63±2.64
	Control	37.90±0.39	48.34±2.24	55.22±3.01	-	-
Springiness (mm)	N_2	10.39±0.06	9.63±0.05	8.71±0.05	7.89±0.04	6.96±0.11
	CO_2	10.39±0.06	9.67±0.04	8.76±0.04	7.96±0.05	7.01±0.08
	Control	10.39±0.06	8.82±0.03	7.43±0.04	-	-

(Table 3).

It can be seen that the significant (P<0.05) increased in hardness, chewiness, cohesiveness and stiffness value of *Cham-Cham* with progressive storage period were observed in both the package containing N_2 and CO_2 at storage temperature of 7±2^{0}C. Both the effect of individual package and the interaction effect of package and storage period during storage were statistically similarly increase for the hardness, chewiness, cohesiveness and stiffness at 7±2^{0}C temperature. Whereas the adhesiveness and the springiness value of stored *Cham-Cham* decreased significantly as the storage period progress in both the package containing N_2 and CO_2 at the storage temperature of 7±2^{0}C. The decreasing of adhesiveness and springiness value of *Cham-Cham* were non-significant for the individual package and the interaction of package and storage period in both the package containing N_2 and CO_2 at the storage temperature of 7±2^{0}C.

Similar findings were reported by Bhatele and Chandran (1983), who observed increased in hardness of *Burfi* samples with the progress of storage period due to moisture loss. Makhecha (2012) found an increased in hardness, chewiness and stiffness value of *Thabdi* stored at 30±2^{0}C and 7±2^{0}C using different packages. A significantly increased in hardness, chewiness and stiffness of *Thabdi peda* stored at 37±2^{0}C and 20±2^{0}C in different MAP were observed by Raval (2013). During storage of *Cham-Cham* at 30±2^{0}C and 7±2^{0}C, an increased in hardness, chewiness and cohesiveness were observed by Sengar (2013). Tiwari (2013) noticed increased of hardness and chewiness during storage of *Burfi* at 37±2^{0}C and 7±2^{0}C. Decrease in adhesiveness and springiness value of *Cham-Cham* was observed by Sengar (2013) when stored at 30±2^{0}C and 7±2^{0}C.

Changes in microbiological attributes of Cham-Cham:

The presences of various types of micro-organisms affect the acidity, FFA, soluble nitrogen, pH etc. The growth rate of micro-organisms changes with changes in temperature and storage condition. The microbial count

Table 4 : Effect of storage period at refrigeration temperature (7±2^{0}C) temperature on the yeast and mold count of *Cham-Cham* packed in different packaging system

Parameter	Packages	Storage period				
		0	7	14	21	28
Standard plate count	N_2	2.84±0.10	3.23±0.07	3.80±0.08	4.04±0.06	4.30±0.02
(cfu/g, log transformed)	CO_2	2.84±0.10	3.09±0.09	3.71±0.10	3.98±0.05	4.16±0.03
	Control	2.84±0.10	3.72±0.08	4.24±0.11	-	-
Yeast and mould count	N_2	Nil	12.33±1.53	19.67±2.08	24.33±2.08	28.67±1.53
(cfu/g)	CO_2	Nil	11.33±1.53	17.00±1.00	19.67±0.58	26.33±0.58
	Control	Nil	1.29±1.09	1.42±1.21	-	-

Table 5 : Effect of storage period at refrigeration temperature (7±2^{0}C) temperature on sensory attributes of *Cham-Cham* packed in different packaging system

Parameter	Packages	Storage period				
		0	7	14	21	28
Flavour (9- point Hedonic	N_2	8.42±0.03	8.02±0.20	7.52±0.20	7.08±0.16	6.71±0.20
scale)	CO_2	8.42±0.03	8.08±0.25	7.71±0.16	7.31±0.13	6.86±0.14
	Control	8.42±0.03	7.61±0.24	7.08±0.19	-	-
Body and texture (9- point	N_2	8.31±0.07	7.79±0.16	7.56±0.19	7.09±0.13	6.77±0.16
Hedonic scale)	CO_2	8.31±0.07	7.90±0.16	7.69±0.13	7.33±0.22	6.92±0.19
	Control	8.31±0.07	7.54±0.14	6.96±0.18	-	-
Colour and appearance (9-	N_2	8.38±0.07	7.83±0.10	7.46±0.16	7.11±0.14	6.79±0.10
point Hedonic scale)	CO_2	8.38±0.07	7.92±0.13	7.56±0.13	7.27±0.13	6.90±0.16
	Control	8.38±0.07	7.71±0.11	7.17±0.14	-	-
Overall acceptability (9- point	N_2	8.36±0.10	7.79±0.16	7.46±0.22	7.21±0.13	6.87±0.16
Hedonic scale)	CO_2	8.36±0.10	7.90±0.16	7.60±0.19	7.27±0.14	6.92±0.13
	Control	8.36±0.10	7.75±0.15	7.19±0.20	-	-

affect the colour and appearance, flavour, body and texture of the product and thus influence its acceptability and hence the shelf-life.

The results of microbiological analysis in form of log transformed values of stored samples of *Cham-Cham* have been compiled and discussed below for standard plate counts (Table 4). Whereas, yeast and mold counts were given in natural number because few in number. The fresh as well as stored samples of *Cham-Cham* did not show any coliform count at any stage of study and hence the same are not reported and discussed here. Arora *et al.* (1995 and 1996) also reported absence of coliform in *Rasogolla.*

The effect of individual package and storage period were significantly increased in SPC and yeast and mold count of *Cham-Cham* as the storage period progress in both the package containing N_2 and CO_2 at storage temperature of 7±2^{0}C. On the other hand, the interaction effect of package and period of storage were found statistically non-significant at 7±2^{0}C temperature of storage on both the package contain N_2 and CO_2.

Sachdeva and Rajorhia (1982) reported increased in SPC and yeast and mold count during storage of *Burfi* at 30^{0}C and 5^{0}C. Other workers also reported increased SPC of *Burfi* during storage (Garg and Mandokhot, 1987) and Misra and Kuila, 1988). Increased in SPC and yeast and mold count of brown *Peda* during storage at 30^{0}C using different packaging techniques were reported by Londhe *et al*. (2012). Sengar (2013) found increased in SPC and yeast and mold count of *Cham-Cham* stored at 30±2^{0}C and 7±2^{0}C. During storage of *Burfi* at 37±2^{0}C and 7±2^{0}C an increased in SPC and yeast and mold count were observed by Tiwari (2013).

Changes in sensory attributes of Cham-Cham :

The sensory attributes have profound effect on the consumer's preference. Subjective evaluation of sensory attributes of any dairy/food is an indicator of the acceptability of the food products stored over a period of time. Panellists were asked to indicate the acceptability of the product on 9-Point Hedonic Scale. The sensory attributes of stored samples of *Cham-Cham* such as flavour, body and texture, colour and appearance as well as overall acceptability were evaluated (Table 5).

With the increased storage period, the significant decreased in flavour, body and texture, colour and appearance and overall acceptability score of *Cham-Cham* were observed in both the package containing N_2 and CO_2 at 7±2^{0}C temperature of storage. It can be found that flavour, colour and appearance and overall acceptability score of *Cham-Cham* packed in N_2 and CO_2 package were not affected significantly ($P<0.05$) by either the individual package or the interaction effect of package and storage period at 7±2^{0}C temperature. Though the two MAP systems individually had little differences in the decrease in body and texture score of *Cham-Cham* at 7±2^{0}C temperature of storage on both the package contain N_2 and CO_2.

At 7±2^{0}C temperature, the product became dry, hard, sandy and brittle which might be due to the loss of moisture and possible crystallization of sugar. This was because of dynamic structural and conformational changes, which may or may not be dependent on changes in moisture content (Navajeevan and Rao, 2008) and can be attributed to decline in hydrophilic groups. Therefore, body and texture was considered as important criteria for determining the acceptability of *Cham-Cham* during storage study particularly at 7±2^{0}C temperature.

Makhecha (2012) reported decreased in flavour, body and texture, colour and appearance and overall acceptability score value of *Thabdi* stored at 30±2^{0}C and 7±2^{0}C temperatures using different packages. Tiwari (2013) prepared *Burfi* and found decreased in flavour, body and texture, colour and appearance and overall acceptability score during storage at 37±2^{0}C and 7±2^{0}C. Sengar (2013) noticed the decreased in flavour, body and texture, colour and appearance and overall acceptability score of *Cham-Cham* stored at 30±2^{0}C and 7±2^{0}C.

Conclusion :

Cham-Cham packed under hygienic conditions in transparent but rigid re-closable PVC tray packages and inserted into Pet-Polyester/Polyfilm pouches (~ 85µ) were flushed with N_2 and CO_2 gas to reduce the head space O_2 level below 4 per cent before heat sealing. The product after packing was stored refrigeration (7±2^{0}C) temperatures at 65 per cent RH. On the basis of storage related changes in compositional, physico-chemical, textural, microbial and sensory attributes, the packaging systems were evaluated. The results suggested that use of CO_2 gas to replace O_2 in head space as compared to N_2. The keeping the product under refrigeration (7±2^{0}C) conditions tends to enhance its shelf-life upto 28 days.

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