



Superchilling of poultry meat for improved storage stability

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ABSTRACT

Superchilling, a new concept of extending shelf life of fresh food products without freezing, has been confined mainly to seafoods and scanty work has been documented on poultry meat. Hence, poultry breast fillets were aerobically packaged and stored under superchilling ($-2\pm 0.5^{\circ}\text{C}$) condition for its storage stability as compared to frozen ($-20\pm 1^{\circ}\text{C}$) fillets. During storage period of 20 days, there was significant decrease in protein and fat content of both superchilled and frozen samples with an improvement in moisture in superchilled samples. The overall pH was significantly low in superchilled fillets at the end of storage. The water holding capacity of superchilled fillet was significantly higher with lower drip loss whereas extract release volume and water activity decreased during storage. The thiobarbituric acid and tyrosine values in both the samples increased significantly from day 10 onwards. The superchilled meat had significantly higher total plate count and psychrophilic count throughout the study. There was significant reduction in Lightness (L^*) and yellowness (b^*) score as well as significant increase in the redness (Hunter a^* value) score of superchilled breast fillet as compared to frozen fillets. The hardness and shear force values were significantly higher in frozen fillets than that of superchilled fillets suggesting the beneficial effect of superchilling in extending the shelf life upto 20 days under aerobic packaging conditions without adverse effect on its quality.

Keywords: Breast fillets, Preservation, Quality evaluation, Shelf life

Foods of animal origin in relation to protein contents are at the top of the food chain and among that, meat occupies the principal position. It contains quality protein, palatability enhancing fat, energy providing carbohydrates, vitamins as well as essential fatty acids and micronutrients which make it a balanced diet for most of the people (Sharma *et al.* 2018). In the year 2018-19, India has produced a total of 8.11 MT of meat (BAHS 2019). Poultry meat, an excellent source of essential nutrients with high-quality proteins, minerals, carbohydrates and pigments (Pateiro *et al.* 2021), is the most preferred meat over other meats throughout the country because of its easy availability, low cost and no religious taboos. Around 72% population of the country is non-vegetarian and regular consumption of meat is increasing continuously over the years (Muthukumar and Naveena 2019). Preservation of meat at low temperature by employing traditional methods such as chilling and freezing is an old concept to extend its shelf life. However, with the increase in demand for fresh foods, the shift from frozen foods (including meat) to fresh products is observed. This could be achieved by transporting meat at chilling temperature or storing it in cold chain till its utilization by the end users. Cooling is intended to slow or

limit the spoilage either by microorganisms (Cassens 1994) or by undesirable enzymatic activities within the meat. Superchilling is a different concept than refrigeration and freezing where the product temperature is reduced $1-2^{\circ}\text{C}$ below its initial freezing point which has the potential to reduce storage and transport costs (Reynolds 2007). The main advantage of this method over traditional ones is that it can retain better food quality and prolong the shelf life of stored foods by 1.5–4 times (Kaale *et al.* 2011). It can also reduce the use of repeated freezing/thawing at retail outlets thereby lowering energy cost in superchilling (Zhou *et al.* 2010).

Nevertheless, most of the earlier studies related to superchilling were largely confined to aquatic products (Gallart-Jornet *et al.* 2007, Kaale *et al.*, 2014), while such studies related to meat viz. in beef (Liu *et al.* 2012) in rabbit meat (Lan *et al.* 2016) and in poultry meat (Lawrence *et al.* 2010) were scanty. Therefore, the present study was conducted to envisage the comparative effect of superchilling on poultry meat (breast fillet) during storage under aerobic packaging condition.

MATERIALS AND METHODS

Meat procurement and treatment: The live broiler birds (6 week age) weighing 1.25 to 1.5 kg were slaughtered, dressed and kept in refrigerator upto 12 h for ageing which were subsequently deboned. Hygienically collected breast fillets packaged (300 g each) in low density polyethylene

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pouches (LDPE) pouches (60 micron) and shifted to freezer ($-20\pm 1^{\circ}\text{C}$) for cooling until (about 1 h and 40 min) the core temperature was approximately -0.5°C . Then the samples were immediately transferred to superchilling ($-2\pm 0.5^{\circ}\text{C}$) temperature for storage and examined at an interval of five days until its spoilage. For analysis, the superchilled ($-2\pm 0.5^{\circ}\text{C}$) and frozen ($-20\pm 1^{\circ}\text{C}$) samples were thawed for 6 and 12 h respectively under refrigeration ($4\pm 1^{\circ}\text{C}$) temperature. Quality of breast fillets during storage period were assessed on the basis of its composition (moisture, total protein and fat), physico-chemical attributes (pH, extract release volume, water holding capacity, water activity, drip loss, TBA value, tyrosine value and water activity), microbiological attributes (total plate count, psychrophilic count), colour and textural (hardness and shear force value) qualities. The experiment was repeated four times and in each experiment, observations were taken in duplicate.

Physico-chemical analysis: The proximate composition (moisture, fat and protein), pH, drip loss of samples were determined by using the standard methods of AOAC (1995). The water holding capacity (WHC) and ERV (extract release volume) of meat samples were determined according to the method of Wardlaw *et al.* (1973) with slight modification and Strange *et al.* (1977) respectively. Thiobarbituric acid number and tyrosine value of meat samples were determined as per the method suggested by Witte *et al.* (1970) and Strange *et al.* (1977) respectively with slight modifications. Water activity (a_w) was measured by water activity analyzer (Rotronic hygropalm-HP23-AW) by putting 1 g sample in sample cup and a_w was recorded after 1 min, at 25°C .

Microbiological analysis: The microbiological quality was assessed on the basis of total plate count (TPC), psychrophilic count (PPC), as per the procedure of APHA (1984). The bacteriological media was obtained from M/s. Himedia, Mumbai, India.

Instrumental colour: The colour of breast fillets was determined by using Hunter Lab Miniscan XE Plus Colorimeter (Hunter Associates Laboratory Inc., Reston, VA, USA) at ICAR-National Research Centre on Meat, Hyderabad using illuminant D65 and the 10° standard observer angle. Meat colour was measured at the surface of breast fillet 30 min after opening of packets in order to allow colour stabilization on exposure to air and then L^* (Lightness), a^* (redness), and b^* (yellowness) values were measured.

Texture analysis: The texture of the product was measured in term of hardness and shear force value using texturometer (Tinius Olsen, Model H1KF, Redhill, RH1 5DZ, England). To measure hardness (N) and shear force (N), all samples of the breast fillets were cooked before use. The procedure used for instrumental texture analysis was similar to those described by Bourne (1978) and Brady *et al.* (1985). To measure hardness (N), cooked breast fillets were cut into 1 sq. cm and compressed to 50% of the original height. A 50 N load cell was used with a load

range of 0-50 N at crosshead and chart speed of 50 mm/min. Two compression cycles per cubes were generated to form a 'two bite' work force compression curve. The texture parameters derived from the two successive compression curves were: (a) Hardness/Firmness, (b) Cohesiveness, (c) Springiness, (d) Gumminess and (e) Chewiness. However, only hardness was taken in to consideration for the analysis and the results were expressed as maximum force (N) of first compression cycle (Brady *et al.* 1985).

To measure shear force (N), six subsamples in a cylindrical shape (diameter 8 mm) were taken from each sample, longitudinally and in the direction of the muscle fibers using tissue borer. The cores were sheared perpendicular to the muscle fibre orientation with 75 Newton load range and a cross head speed set at 200 mm/min. The force required to shear the samples were recorded in Newton (N).

Statistical analysis: The experiment was repeated four times and the observations were taken in duplicate. The data thus obtained was subjected to Factorial Complete Randomized Design (Snedecor and Cochran 1989) using online data analysis package WASP (Web Agri Stat Package) developed by ICAR-Central Coastal Agricultural Research Institute, Goa. The significance was defined at a level of $P < 0.05$.

RESULTS AND DISCUSSION

Proximate analysis: There was significant reduction in moisture of frozen as well as superchilled samples throughout the storage (Table 1) which might be due to the decrease in pH, loss of adenosine triphosphate (ATP) and conditioning (Huff-Lonergan and Lonergan 2005) during storage. However, the moisture per cent in the frozen sample was significantly lower than the superchilled sample. This reduction in moisture could be due to sublimation of surface water of the meat to colder surface in the vicinity of freezer (Taylor *et al.* 1990). The per cent protein of both the samples decreased significantly during the storage. Nevertheless, it was significantly higher in superchilled sample than the frozen sample.

Duun and Rustard (2008) also reported a lower degree of protein degradation in superchilled Salmon fillets stored at -3.6°C than fillets stored at -1.4°C . This degradation in protein might be due to activity of endogenous enzymes and microorganisms (Ueng and Chow 1998). Similarly, the fat per cent in all the samples indicated significant decrease during storage period. This decrease in fat might be due to lipid oxidation during storage (Kandeean and Biswas 2007). However, there were no significant variations in fat per cent of superchilled and frozen sample at the end of storage. Similar observations were made earlier by Kandeean and Biswas (2005) in buffalo meat during storage at -10°C for 75 days.

Physicochemical properties: The pH of both the samples (Table 2) decreased significantly from day zero to day 10 which might be attributed to the accumulation of inorganic phosphoric acid resulting from the depletion of

Table 1. Proximate analysis of aerobically packed superchilled poultry meat during storage

Treatment	Storage period (days)					Factor A (Treatment mean)
	0	5	10	15	20	
Moisture (%)						
Superchilled (-1.5 to -2.5°C)	75.24±0.34	74.11±0.17	72.93±0.17	71.89±0.21	71.16±0.26	73.07±0.25 ^A
Frozen (-20±1°C)	74.75±0.30	73.5±0.21	72.45±0.39	71.38±0.26	70.52±0.11	72.52±0.26 ^B
(Days mean) Factor B	74.99±0.23 ^a	73.81±0.18 ^b	72.69±0.21 ^c	71.63±0.17 ^d	70.84±0.16 ^e	Coefficient of variation = 0.822
	Factor A	Factor B	A × B	Error		
Mean sum of squares (MSS)	6.006	44.132	0.022	0.358		
F cal	16.792	123.39	0.062			
CD @ 5%	0.267	0.422	0.597			
Protein (%)						
Superchilled (-1.5 to -2.5°C)	18.83±0.15	19.04±0.16	18.84±0.19	18.65±0.10	18.47±0.12	18.77±0.07 ^A
Frozen (-20±1°C)	18.72±0.05	18.50±0.09	18.42±0.09	18.12±0.07	17.91±0.09	18.33±0.05 ^B
(Days mean) Factor B	18.78±0.07 ^a	18.77±0.11 ^a	18.63±0.11 ^a	18.38±0.08 ^{bc}	18.18±0.10 ^c	Coefficient of variation = 1.685
	Factor A	Factor B	A × B	Error		
(MSS)	3.75	1.063	0.135	0.098		
F cal	38.401	10.884	1.387	-		
CD @ 5%	0.14	0.221	0.312			
Fat (%)						
Superchilled (-1.5 to -2.5°C)	4.41±0.06	4.37±0.05	4.34±0.05	4.32±0.05	4.28±0.05	4.34±0.03
Frozen (-20±1°C)	4.47±0.03	4.31±0.03	4.29±0.05	4.27±0.03	4.25±0.01	4.32±0.02
(Days mean) Factor B	4.44±0.03 ^a	4.34±0.02 ^b	4.32±0.03 ^b	4.29±0.03 ^b	4.27±0.02 ^b	Coefficient of variation = 2.451
	Factor A	Factor B	A × B	Error		
MSS	0.012	0.07	0.01	0.011		
F cal	1.043	6.223	0.879	-		
CD 5%	0.047	0.075	0.106			

Means±SE (n=8) with different superscripts in a row (small letters) or column (Capital letters) differ significantly (P<0.05).

muscle adenosine triphosphate (Scherer *et al.* 2006) and the production of lactic acid resulting from the decomposition of glycogen (Kozioł *et al.* 2015). Subsequent increase in pH during storage from day 15 might be due to production of ammonia, amines and other basic substances from the degradation of proteins by microorganisms and endogenous enzymes (Muela *et al.* 2010). However, the overall pH was

significantly low in superchilled meat than frozen sample at the end of storage which is supported by the findings of Lan *et al.* (2016) in superchilled rabbit hind leg during storage.

Superchilled meat had significantly higher ERV on day zero than frozen sample which then decreased during storage period and was significantly lower than the frozen meat at the end of storage. This decrease in ERV might

Table 2. Physico-chemical changes in aerobically packed superchilled poultry meat during storage

Treatment	Storage period (days)					Factor A (Treatment mean)
	0	5	10	15	20	
<i>pH</i>						
Superchilled (-1.5 to -2.5°C)	5.92±0.06 ^A	5.81±0.04 ^A	5.72±0.05 ^A	5.89±0.04	6.08±0.03 ^A	5.89±0.03 ^A
Frozen (-20±1 °C)	6.08±0.04 ^B	5.96±0.03 ^B	5.91±0.03 ^B	5.87±0.02	5.89±0.02 ^B	5.94±0.02 ^B
(Days mean) Factor B	6.00±0.04 ^a	5.90±0.03 ^a	5.82±0.03 ^{cd}	5.88±0.02 ^d	5.98±0.03 ^c	Coefficient of variation =
	Factor A	Factor B	A × B	Error		
MSS	0.052	0.091	0.104	0.009	1.603	
F cal	5.787	10.118	11.563	-		
CD @ 5%	0.042	0.067	0.095			

Treatment	Storage period (days)					Factor A (Treatment mean)
	0	5	10	15	20	
<i>ERV (ml)</i>						
Superchilled (-1.5 to -2.5°C)	30.63±0.25 ^A	29.53±0.46	27.58±0.21 ^A	25.86±0.33 ^A	24.88±0.23 ^A	27.69±0.37 ^A
Frozen (-20±1°C)	29.33±0.54 ^B	29.01±0.31	28.66±0.28 ^B	28.21±0.32 ^B	27.74±0.32 ^B	28.59±0.18 ^B
(Days mean) Factor B	29.98±0.33 ^a	29.27±0.28 ^b	28.12±0.23 ^c	27.04±0.38 ^d	26.31±0.42 ^e	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 3.247	
MSS	16.11	36.88	12.824	0.835		
F cal	19.299	44.18	15.363	-		
CD @ 5%	0.408	0.645	0.913			
<i>WHC (%)</i>						
Superchilled (-1.5 to -2.5°C)	63.98±0.22	62.52±0.16	61.55±0.12	61.16±0.12	60.29±0.22	61.90±0.21 ^A
Frozen (-20±1°C)	63.13±0.26	62.23±0.41	61.36±0.28	60.84±0.23	59.48±0.35	61.41±0.24 ^B
(Days mean) Factor B	63.55±0.20 ^a	62.38±0.21 ^b	61.45±0.15 ^{cd}	61.00±0.13 ^d	59.89±0.22 ^e	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 1.176	
MSS	4.773	30.892	0.387	0.525		
F cal	9.086	58.808	0.737	-		
CD @ 5%	0.324	0.512	0.724			
<i>TBA (mg malanoaldehyde/kg)</i>						
Superchilled (-1.5 to -2.5°C)	0.178±0.01	0.189±0.02	0.248±0.02 ^A	0.419±0.03 ^A	0.816±0.02 ^A	0.37±0.04 ^A
Frozen (-20±1°C)	0.168±0.01	0.173±0.01	0.184±0.02 ^B	0.197±0.03 ^B	0.261±0.04 ^B	0.20±0.01 ^B
(Days mean) Factor B	0.173±0.01 ^a	0.181±0.04 ^{ab}	0.216±0.02 ^b	0.308±0.03 ^c	0.538±0.07 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 15.499	
MSS	0.601	0.372	0.211	0.002		
F cal	311.759	192.938	109.276	-		
CD @ 5%	0.02	0.031	0.044			
<i>Tyrosine (mg/100 g)</i>						
Superchilled (-1.5 to -2.5°C)	22.10±0.31	23.40±0.25 ^A	24.23±0.80 ^A	31.89±0.33 ^A	36.41±0.22 ^A	27.61±0.94 ^A
Frozen (-20±1°C)	21.03±0.22	20.98±0.15 ^B	21.75±0.11 ^B	21.95±0.15 ^B	22.33±0.13 ^B	21.61±0.11 ^B
(Days mean) Factor B	21.56±0.23 ^a	22.19±0.34 ^{ab}	22.99±0.51 ^b	26.92±1.29 ^c	29.37±1.91 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 5.606	
MSS	720	183.057	130.373	1.903		
F cal	378.38	96.201	68.515	-		
CD @ 5%	0.616	0.974	1.378			
<i>Water activity (a_w)</i>						
Superchilled (-1.5 to -2.5°C)	0.937±0.01	0.926±0.02	0.894±0.01	0.874±0.01	0.853±0.02	0.897±0.01
Frozen (-20±1°C)	0.905±0.01	0.890±0.02	0.887±0.01	0.878±0.01	0.869±0.02	0.886±0.02
(Days mean) Factor B	0.921±0.01 ^a	0.908±0.02 ^a	0.890±0.01 ^{bc}	0.876±0.01 ^{cd}	0.861±0.02 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 1.673	
MSS	0.002	0.009	0.002	0.02		
F cal	11.129	41.684	8.707	-		
CD @ 5%	0.007	0.011	0.015			
<i>Drip loss (%)</i>						
Superchilled (-1.5 to -2.5°C)	0	1.74±0.01 ^A	1.75±0.06 ^A	1.79±0.09 ^A	1.86±0.08 ^A	1.43±0.12 ^A
Frozen (-20±1°C)	0	2.25±0.02 ^B	2.76±0.07 ^B	3.16±0.11 ^B	3.25±0.16 ^B	2.28±0.19 ^B
(Days mean) Factor B	0	1.99±0.06 ^a	2.25±0.14 ^b	2.47±0.18 ^c	2.55±0.19 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 8.565	
MSS	14.629	17.949	1.417	0.025		
F cal	580.074	711.721	56.201	-		
CD @ 5%	0.071	0.112	0.159			

Means±SE (n=8) with different superscripts in a row (small letters) or column (Capital letters) differ significantly (P<0.05).

be due to the denaturation of proteins contributing to proteolysis during storage (Jay 1966) as evident from the results of tyrosine values.

The WHC of superchilled fillet was significantly higher than the frozen fillet during the storage study. However, there was gradual and significant decline in per cent WHC during the storage period which might be the effect of mechanical damage to cell membrane at lower temperature (Anese *et al.* 2012). There was significant reduction in WHC of frozen meat as compared to superchilled meat indicating severe effect of freeze denaturation of muscle proteins at $-20\pm 1^\circ\text{C}$ than at $-2\pm 0.5^\circ\text{C}$. Present findings were in agreement with that of Duun and Rustard (2007) in superchilled and chilled cod fillets.

With the advancement in storage period, there was significant increase in TBA value in all samples. However, the rate of increase in TBA value in frozen meat was lower than in superchilled samples. This observation was pinpointing towards the fact that even at low temperature, there was initiation of lipid oxidation which is supported by Benjakul and Bauer (2001) who stated that injury to muscle as a result of formation of ice crystals was responsible for subsequent release of pro-oxidants for lipid oxidation. Similarly, Lan *et al.* (2016) also reported this trend in TBARS value of rabbit hind legs stored at 4°C , superchilled storage at -2.5°C and superchilled storage at -4°C .

There was no significant increase in the tyrosine value of the samples up to 5th day of storage. Thereafter, it was increased significantly throughout the storage. Moreover, there was significant increase in tyrosine value of both the treatment during the entire storage period which might be attributed to protein degradation reactions initiated by meat spoilage bacteria and endogenous enzymes (Muela *et al.* 2010) although low temperatures can inhibit these

reactions (Ueng and Chow 1998). These results are in agreement to that of Lan *et al.* (2016) who reported lowest degree of protein decomposition in muscles stored at -4°C indicating that the lower superchilled temperatures reduces proteolysis degradation. Duun and Rustad (2008) also documented a lower degree of protein degradation in superchilled Salmon fillets stored at -3.6°C as compared to that observed in fillets stored at -1.4°C . Strange *et al.* (1977) noted an increase in tyrosine content with microbial growth during microbial spoilage. Increased tyrosine was also reported with increase in storage temperature (Ziauddin *et al.* 1993).

There was no significant change in a_w of superchilled as well as frozen fillets. However, the a_w of superchilled chicken fillets decreased significantly than frozen chicken fillets during the entire storage. Similar findings were reported earlier by Warris (2010) in meat during exposure to frozen storage.

The superchilling had significant effect on drip of the meat. It was evident that the superchilled meat had significantly low drip loss than the frozen meat. As the storage period increased, there was significant increase of drip in both the samples. However, this increase was significantly higher in frozen meat than superchilled meat which might be due to lower amount of frozen water in superchilled fillets as compared to frozen fillets leading to less change in microstructure, which in turn may result in a lower degree of freeze denaturation and less drip loss (Einarsson 1988). The results are in agreement of Kaale and Eikevik (2014) who reported significantly lower drip loss in superchilled samples than chilled and frozen samples. Duun and Rustard (2007) also claimed less drip loss in superchilled cod fillets than frozen (-21°C) samples. During superchilling, a fraction of the water is frozen

Table 3. Microbiological changes in aerobically packed superchilled poultry meat during storage

Treatment	Storage period (days)					Factor A (Treatment Mean)
	0	5	10	15	20	
<i>TPC (Log₁₀cfu/g)</i>						
Superchilled (-1.5 to -2.5°C)	4.29±0.07	4.34±0.06	4.63±0.11 ^A	4.96±0.10 ^A	5.55±0.12 ^A	4.75±0.08 ^A
Frozen (-20±1°C)	4.14±0.14	4.25±0.12	4.37±0.13 ^B	4.53±0.14 ^B	4.73±0.11 ^B	4.40±0.06 ^B
(Days mean) Factor B	4.21±0.08 ^a	4.30±0.07 ^a	4.50±0.09 ^b	4.75±0.10 ^c	5.14±0.13 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 5.703	
MSS	2.429	2.239	0.341	0.068		
F cal	35.623	32.837	5.002	-		
CD @ 5%	0.117	0.184	0.261			
<i>PPC (Log₁₀cfu/g)</i>						
Superchilled (-1.5 to -2.5°C)	1.97±0.03 ^A	1.99±0.05 ^A	2.39±0.09 ^A	2.59±0.09 ^A	2.70±0.06 ^A	2.33±0.06 ^A
Frozen (-20±1°C)	1.63±0.02 ^B	1.76±0.04 ^B	1.87±0.06 ^B	2.01±0.07 ^B	2.16±0.08 ^B	1.88±0.04 ^B
(Days mean) Factor B	1.80±0.05 ^a	1.87±0.04 ^a	2.13±0.08 ^b	2.30±0.09 ^c	2.43±0.09 ^d	
	Factor A	Factor B	A × B	Error	Coefficient of variation = 7.616	
MSS	3.929	1.151	0.089	0.026		
F cal	152.67	44.711	3.449	-		
CD @ 5%	0.072	0.113	0.16			

Means±S E (n=8) with different superscripts in a row (small letters) or column (Capital letters) differ significantly (P<0.05).

and the results seems to be that the water is better retained by the muscle as long as no outer force is applied.

Microbiological analysis: There was gradual increase (Table 3) in total plate count (TPC) during entire storage period of 20 days. However, there was no significant increase in TPC up to day 5 but from day 10 onwards, the TPC was lowered significantly in frozen fillet than the superchilled fillets which could be attributed to freezing effect due to which microbes became dormant and did not appear in such meat (Leygonie *et al.* 2012). Similarly, the psychrophillic count (PPC) also increased significantly during the storage period. There was significant increase in PPC of both the samples after 10th day of storage. The superchilled meat had significantly higher psychrophillic count throughout the study. The increased enzymatic activity of psychrotrophs at $-2\pm 0.5^{\circ}\text{C}$ temperature might have contributed to deterioration of meat quality (Kandeepan and Biswas 2007). Further, no *E.coli* and *Salmonella* were detected before or after storage indicating no contamination of samples during handling. Similar observations were also recorded by Choe *et al.* (2016) in lamb.

Texture and colour: The frozen fillets had significantly higher hardness (Fig. 1) than that of superchilled fillets. However, at the end of storage, this increase was significantly low in superchilled breast fillet. Similar results were recorded by Duun and Rustard (2008) in Atlantic Salmon who recorded significantly higher hardness value

in those stored at -3.6°C compared to those stored at -1.4°C . This might be due to less degree of denaturation of proteins in frozen meat at -20°C . Endogenous proteolysis might have resulted in myofilament degradation and in turn, the change of texture in muscle. However, there were no clear relationship between texture and endogenous autolytic proteases (Chun-hua *et al.* 2014).

Colour plays an important role in the appearance, presentation and acceptability of meat. Lightness (L^*), redness (a^*) and yellowness (Hunter b^*) values were affected markedly due to superchilling temperature (Fig. 2). There was significant reduction in Lightness (L^*) score of the superchilled breast fillet as compared to frozen fillets at the end of storage. Similarly, there was significant increase in the redness (Hunter a^* value) score of superchilled breast fillet as compared to frozen fillets. This significant increase in redness score (Hunter a^* value) might be due to the oxidation of myoglobin (Choi *et al.* 2016) in aerobically packaged breast fillets. However, there was significant decrease in yellowness (Hunter b^* value) scores of the superchilled breast fillet as compared to frozen fillet indicating beneficial effect of superchilling of breast fillet. The results are well supported by the earlier findings of Lan *et al.* (2016) who reported significant decrease of L^* in rabbit hind legs stored for 28 days at -4°C and -2.5°C temperature.

Poultry meat (breast fillets) superchilled at $-2\pm 0.5^{\circ}\text{C}$ could be stored upto 20 days under aerobic packaging condition, without adverse effect on its quality representing an advantage of superchilling technique over traditional methods to preserve freshness of breast fillets.

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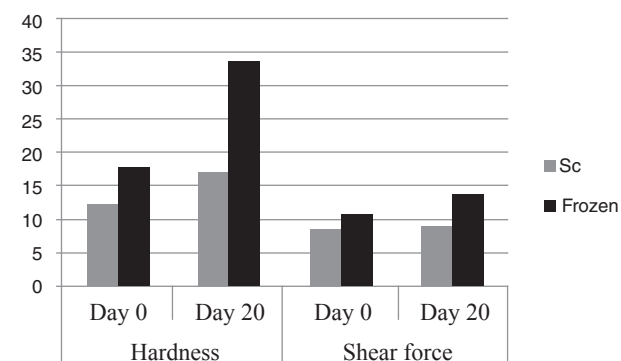


Fig. 1. Effect of superchilling on texture profile of aerobically packed poultry meat.

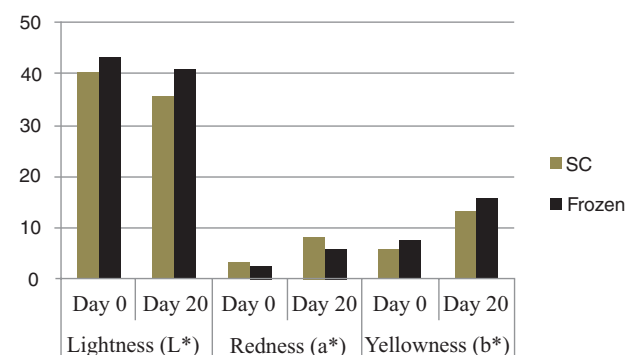


Fig. 2. Effect of superchilling on colour of aerobically packed poultry meat.

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