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Research Paper

Quality of Super Chilled Poultry Meat at Storage

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ABSTRACT

The breast meat upon exposure to super chilling (-1.5 to -2.5°C), chilled (4°C) and frozen (-18°C) temperatures up to 24 h were assessed separately for various quality attributes. The moisture content of super chilled meat (75.74+0.53) was significantly less than chilled meat (78.09+0.49). The protein content was higher in fresh meat (20.56+0.31) as compared to chilled (18.13+0.39) and super chilled meat (18.78+0.27) while fat content was not affected. The pH and water holding capacity (WHC) showed non-significant effect of cooling. There was significant ($p<0.05$) reduction in drip loss in super chilled meat samples as compared to chilled and frozen samples. The water activity (a_w) in frozen and super chilled fillets reduced significantly ($P<0.05$) as compared to fresh meat. There was non-significant ($p>0.05$) increase in total plate count (TPC) of super chilled (4.29+0.19) and frozen fillets (4.13+0.17) whereas in chilled samples, the increase in TPC (4.69+0.23) was significant ($p<0.05$). However, psychrophillic (PPC) increased significantly ($p<0.05$) in both chilled (2.48+0.20) and super chilled fillets (1.98+0.20). The texture of super chilled fillets was comparable with chilled and frozen fillet as evident from shear force values. There was reduction in L* and b* in super chilled breast fillet against frozen and chilled fillet. Moreover, a* value increased significantly suggesting the beneficial effect of super chilling in improving the redness of breast fillet.

Keywords : *Poultry meat, Super chilling, Storage, Quality evaluation*

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INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India today. Due to increasing demand for animal protein, its production was expected to rise at 6% with a forecast of 2.2 kg per capita per annum consumption of poultry meat in the year 2014 (Yadav and Saxena 2014). 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.

Super chilling is a different concept than refrigeration and freezing and it 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 hereby lower energy cost in super chilling (Zhou *et al.* 2010).

Nevertheless, most of the earlier studies related to super chilling were largely confined to aquatic products (Gallart Jornet *et al.* 2007; Kaale *et al.* 2014). While such studies related to meat (Liu *et al.* 2012 in beef; Lan *et al.* 2016 in rabbit meat; Lawrence *et al.* 2010 in poultry meat) were scanty. Therefore, the present study was conducted to envisage the comparative effect of super chilling, chilling and freezing on poultry meat (breast fillet) at 24 h of storage.

MATERIALS AND METHODS

Meat procurement and treatment: The live broiler birds (6 week age) weighing 1.25 to 1.5 kg weight procured from Indian Broiler, Nagpur were slaughtered. Freshly dressed poultry carcasses were kept in refrigerator for 12 h for ageing which were subsequently deboned. Only breast fillets were used for the study which were packaged aerobically in low density polyethylene (LDPE) pouches (50 micron) and shifted to freezer (-20°C) for cooling until (about 1h and 40 min) the core temperature was approximately -0.5°C. The samples each were then immediately transferred to chilling (0 to 4°C) and super chilling (-1.5 to -2.5°C) temperature for 24 h. The fresh meat was analyzed on the day of processing. Prior to analysis, the super chilled (-1.5 to -2.5°C) and frozen (-20°C) samples were thawed for 12 h at chilling (0 to 4°C) temperature.

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Physico-chemical analysis:

The proximate composition: The proximate composition (moisture, fat and protein) of all treated samples were determined by methods of AOAC (1995).

pH and WHC: The pH of a product was determined by method of AOAC (1995). The water holding capacity (WHC) of meat samples was determined according to the method of Wardlaw *et al.* (1973) with slight modification. 20g of minced meat was blended with 30ml chilled NaCl (0.6M) in centrifuge tube which is stirred for 1 min with the help of glass rod which was then hold at 4°C for 15 min, after that sample was allowed to centrifuge at 5000 rpm for 15 min (REMI- R- 24). The supernatant obtained was measured and amount of water retained by sample was expressed in percentage.

Drip loss: Drip loss of meat samples were determined by the method of AOAC (1995) from the known weights of before and after thawing and expressed as:

$$\% \text{ Drip loss} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Water activity **(a_w):** It 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 the specific temperature (25°C).

Instrumental colour: The colour of breast fillets were determined by using Hunter Lab Miniscan XE Plus Colorimeter (Hunter Associates Laboratory Inc., Reston, VA, USA) at 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 (shear force value) analysis: To measure shear force (N), breast fillet were cooked and six subsamples in a cylindrical shape (diameter 8mm) were taken from each sample, longitudinally and in the direction of the muscle fibers using tissue borer. The Warner – Bratzler shear force (WBSF) of the cores were measured using texturometer (Tinius Olsen, Model H1KF, 6 Perrywood Business park, Redhill, RH1 5DZ, England) with V shaped stainless steel Blade (60° angle) and triangular whole in the middle. The cores were sheared perpendicular to the muscle fibre orientation with 75 Newton load range and a cross head speed set at 200 mm/minute. The force required to shear the samples were recorded in Newton (N).

Microbiological analysis: The microbiological evaluation of treated breast fillets were carried out in terms of Total Plate Count (TPC), Psychrophillic Count (PPC) and Coliform count following the method of APHA (1984).

Statistical analysis: The experiment was repeated three times and the observations were taken in duplicate. The data thus obtained were analyzed using online data analysis package WASP (Web Agri Stat Package) developed by ICAR-Central Costal Agricultural Research Institute, Goa. The significance was defined at a level of $p<0.05$.

RESULTS AND DISCUSSION

Proximate composition: The moisture content (Table 1) of fresh and super chilled breast fillet did not differ significantly ($p>0.05$). However, chilled meat had significantly higher moisture as compared to frozen and super chilled breast fillet indicating their reduction in the moisture content of meat due to super chilling. This reduction in the moisture could be due to evaporation of moisture from meat during storage (Arief *et al.* 1989) and sublimation of surface water of the meat to colder surface in the vicinity of freezer (Taylor *et al.* 1990). Cooling treatments had significantly lowered the protein content (Table 1) as compared to fresh meat which might be due to protein denaturation, drip loss and proteolysis induced by enzymatic activities of psychrotrophs (Peterson and Gunderson 1960) as well as increased microbial growth resulted from higher water activity (a_w) and enzymatic autolysis (Rao *et al.* 1998). The fat content of breast fillets was not significantly affected by the cooling treatments.

pH and WHC: The pH of super chilled breast fillet was reduced in comparison to that of fresh meat. However, all the samples showed non-significant deviations in pH. This could be attributed to the post mortem conversion of muscle glycogen to lactic acid which has an important bearing on the keeping quality of meat (Gracy 1981). The WHC of chilled (4°C), frozen (-18°C) and super chilled (-1.5 to -2.5°C) breast fillet showed non-significant variations which were in agreement with the observations of Kaale *et al.* (2014) in super chilled Atlantic salmon (*Salmo salar*) muscle as compared to chilled and frozen samples. However, the WHC values of chilled, frozen and super chilled samples were lower than the WHC of fresh breast fillet. This decrease in WHC in treated samples could be attributed to the rate of post mortem pH decline, high ionic strength, and protein denaturation and enhanced movement of water into extracellular space (Kondaiah *et al.* 1986).

Drip loss: Significant reduction in drip loss (Table 1) was observed in super chilled breast fillet at 24 h storage as compared to chilled and frozen samples. The results were in

agreement with the Kaale *et al.* (2014) who studied the effect of super chilling on WHC and drip loss of Atlantic salmon (*Salmo salar*) muscle. These findings are valuable for the super chilling industry because they provide beneficial information on the quality of food products. Moreover, this reduction in drip loss of super chilled samples might be due to small amount of water in frozen form as compared to frozen samples resulting in less enzymes and salt concentration in the remaining water (Kaale and Eikevik 2014). High drip loss in frozen sample could be the result of mechanical damage to cell membranes caused by destruction of muscular tissue due to freezing resulting in low WHC (Anese *et al.* 2012).

Water activity (a_w): The results on a_w of chilled, frozen, super chilled and fresh breast fillet at 24 h storage revealed significant reduction of a_w in frozen and super chilled fillet which corroborated the fact that the freezing lowered a_w (Warris 2010). However non significant variations in a_w of chilled and super chilled fillet as well as frozen and super chilled fillet were observed.

Microbiological analysis: In the present study, TPC increased significantly ($p<0.05$) in chilled fillet as compared to fresh meat. However, increase in TPC of frozen and super chilled breast fillet was non-significant. This could be due to the damage caused to the cells through the formation of ice crystals (Warris 2010) preventing the growth of bacteria by reducing the availability of water as it forms ice. However, release of drip which has provided excellent medium for microbial growth (Nirmal and Benjakal 2010) might be the reason for increase in TPC in treated samples as compared to fresh meat. The PPC increased significantly in chilled and super chilled breast fillet as compared to fresh and frozen fillet. This increased PPC in chilled and super chilled breast fillet could be due to increased enzymatic activity of psychrotrophs at low temperature that might have contributed to deterioration of meat quality (Kandeepan and Biswas 2007). Significant increase in TPC and PPC counts during refrigerated storage was also reported by Santosh Kumar *et al*. (2016). The coliforms were not detected in any of the samples throughout the study.

Warner-Bratzler shear force (WBSF): Lower shear force value of superchilled meat was recorded as compared to frozen as well as chilled fillets. Nevertheless, these values did not differ significantly. These results were in agreement with Lan *et al.* (2016) who also observed lower values of shear force for superchilled rabbit hind leg than chilled rabbit hind leg. This slight reduction in shear force value could be due to the loss of membrane strength caused by ice crystal formation (Laygonie *et al.* 2012).

Changes in colour: Lightness (L*), redness (a*) and yellowness (Hunter b* value) were affected markedly due to super chilling temperature. The results indicated significant reduction in lightness score and yellowness in super chilled breast fillet against frozen and chilled fillet. The redness score increased significantly suggesting the beneficial effect of super chilling in improving the redness of breast fillet. Similarly Lan *et al.*, (2016) reported significant decrease in L* in rabbit hind legs stored for 28 days at super chilled at 4 °C and 2.5 °C. Duun and Rustad (2008) also obtained a lower L* in salmon fillets stored at 1.4°C than in fillets stored at 3.6°C.

Table 1: Effect of super chilling treatment on physicochemical and microbiological qualities of aerobically packed poultry meat at 24h storage (n=6)

S.No.	Quality attributes	Chilling	Freezing	Super chilling	Fresh meat
		0-4 °C	-20 °C	-1.5 to -2.5 °C	
1	Moisture (%)	78.09+0.49^{a}	75.79+0.32^{b}	75.74+0.53^{b}	74.96+0.25^{b}
2	Protein (%)	18.13+0.39^{a}	18.71+0.23^{a}	18.78+0.27^{a}	20.56+0.31^{b}
3	Fat (%)	4.07+0.26	4.26+0.09	4.29+0.10	4.39+0.29
4	pH	5.98+0.21	6.07+0.14	5.93+0.16	6.19+0.10
5	ERV(ml)	27.26+0.48^{a}	29.5+0.50^{b}	29+0.42^{b}	29.46+0.37^{b}
6	WHC (%)	61.49+0.88	63.16+0.72	62.82+0.45	66.07+0.43
7	a_w	0.944+0.07^{ab}	0.906+0.06^{c}	0.928+0.05^{bc}	0.966+0.05^{a}
8	Drip loss (%)	1.66+0.14^{a}	2.23+0.29^{a}	1.72+0.12^{b}	-
9	TPC (Log_{10}cfu/g)	4.69+0.23^{a}	4.13+0.17^{b}	4.29+0.19^{ab}	4.02+0.29^{b}
10	PPC (Log_{10}cfu/g)	2.48+0.20^{a}	1.65+0.23^{c}	1.98+0.20^{b}	1.44+0.10^{c}
11	Texture Shear Force Value (N)	8.93+0.86	12.56+1.05	9.72.+0.68	Not recorded

Different superscripts in a row differ significantly ($P<0.05$)

Table 2: Effect of super chilling treatment on colour of aerobically packed poultry meat

Sr. No.	Treatment	Colour Parameters		
		Lightness (L*)	Redness (a*)	Yellowness (b*)
1	Chilling (0-4 ºC)	43.14+0.62[a]	-1.73+0.22[b]	8.28+0.24[a]
2	Freezing (-20 ºC)	40.81+0.54[a]	-2.41+41[b]	7.12+0.62[a]
3	Super chilling (-1.5 to -2.5 ºC)	34.85+0.98[b]	0.3+0.47[a]	4.26+0.5[b]

Different superscripts in a column differ significantly (P<0.05)

CONCLUSION

The study represented an advantage of super chilling over traditional methods to preserve freshness of breast fillet with improvement in the quality characteristics and thus there is a need to study the shelf life of poultry meat by super chilling concept.

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REFERENCES

Anese M, Manzocco L, Panozzo A, Beraldo P, Foschia M, Nicoll MC (2012) Effect of radio frequency assisted freezing on meat microstructure and quality. Food Res Int 46(1): 50–54

Arief MA, Reddy KP, Reddy VR (1989) Influence of packaging (wrapping) material and storage periods on certain chemical and organoleptic characteristics of broiler cut up parts. Kerala J Vet Sci 20: 107-114

AOAC (1995) Official Methods of Analysis. Association of Official Agricultural Chemists, Washington, DC

APHA (1984) Compendium of methods for the microbiological examination of foods, 2nd edn. M. L.Speck, American Public Health Association, Washington, DC

Cassens RG (1994) Meat preservation, preventing losses and assuring safety. 1st edn. Food and Nutrition Press, Inc. Trumbull, Connecticut, USA Duun AS, Rustad T (2008) Quality of superchilled vacuum packed Atlantic salmon (*Salmo salar*) fillets stored at -1.4 and -3.6 °C. Food Chem 106: 122–131

Gallart-Jornet L, Rustad T, Barat JM, Fito P, Escriche I. (2007) Effect of superchilled storage on the freshness and salting behaviour of Atlantic salmon (*Salmo salar*) fillets. Food Chem 103(4): 1268–1281.

Gracey JF (1981) Meat Hygiene. 7th Edn. The English Language. Book Society and Billiere Tindall, London.

Kaale LD, Eikevik TM, Rustad T, Kolsaker K. (2011) Superchilling of food: A review. J Food Eng 107(2): 141–146

Kaale LD, Eikevik TM (2014) The development of ice crystals in food products during the superchilling process and following storage, a review. Trends in Food Sci Technol 39: 91-103

Kaale LD, Eikevik TM, Rustad T, Nordtvedt TS (2014) Changes in water holding capacity and drip loss of Atlantic salmon (*Salmo salar*) muscle during superchilled storage. LWT Food Sci Technol 55 (2): 528–535

Kandeepan G, Biswas S (2007) Effect of domestic refrigeration on keeping quality of buffalo meat. J Food Tech 5(1): 29 – 35

Kondaiah N, Anjaneyulu ASR, V Kesava Rao, Sharma N (1986) Effect of different handling condition on quality of minced buffalo meat. Indian J Anim Sci 56: 677-679

Lawrance Paul, Mark Woolfe, Chrissie Tsampazi (2010) The effect of superchilling and rapid freezing on HADA assay for chicken and turkey. J Asso Publ Analysis 38: 13-23

Lan Yang, Yongbiao Shang, Ying Song, Quan Dong (2016) Changes in the quality of superchilled rabbit meat stored at different temperatures. Meat Sci 117: 173-181

Leygonie C, Britz TJ, Hoffman LC (2012) Impact of freezing and thawing on the quality of meat: Review. Meat Sci 91(2): 93–98

Liu Q, Wang R, Kong BH, Zhang YG (2012) Effect of superchilling storage on quality characteristics of Beef as compared with chilled and frozen preservation. Advanced Material Research Vol. 554-556: 1195-1201

Nirmal NP, Benjakal S (2010) Effect of catechin and ferulic acid on melanosis and quality of pacific white shrimp subjected to prior freeze-thawing during refrigeration storage. Food Control 21: 126-1271.

Peterson AC, Gunderson MG (1960) Some characteristics of proteolytic enzymes from Pseudomonas fluorescence. Applied Microbiol 8: 98-103.

Rao DN, Nair KKS, Sakhare PZ (1998) Meat microbiology and spoilage in tropical countries. In: Microbiology of Meat and Poultry. Davies, A. and R. Board (Eds), Blackie Academic and Professional, London

Reynolds G (2007) Super chilling keeps fish fresh longer, claim scientists. Retrieved on 01st June 2015, from *http://www.foodqualitynews.com/Innovation/Superchilling-keeps-fish-fresh-longer-claim-scientists.*

Santosh Kumar HT, Pal UK, Mandal PK, Das CD (2016) Quality and shelf life of dressed chicken from different sources under refrigeration (4±1^{O}C). J Meat Sci 11: 26-30.

Taylor AA, Down NF, Shaw BG (1990) A composition of modified atmosphere and vacuum skin packaging for the storage of red meat. Int J Food Sci Technol 25: 98-109

Wardlaw FB, McCaskill LH, Acton JC (1973) Effect of post mortem muscle changes on poultry meat loaf properties. J Food Sci 38(3): 421-423.

Warris PD (2010) Meat Science - An Introductory Text. 2nd edn. CABI, Wallingford Oxfordshire, UK

Yadav AS, Saxena GK (2014) Innovative approaches for microbial decontamination of poultry carcasses. In: Souvenir, 6th Conference of Indian Meat Science Association (IMSACON VI) and National Symposium on Sustainable Meat Production for Nutritional Security and Consumer Well-being: Challenges and Strategies held during 28-30 November, 2014 at DUVASU, Mathura, UP (India) pp 88-91

Zhou GH, Xu XL, Liu Y (2010). Preservation technologies for fresh meat-A review. Meat Sci 86: 119-128.