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Effect of Low Temperature Preservation and Post-Thawing on Chemical Attributes of Buffen, Chevon and Chicken Meat

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ABSTRACT

Traditionally, meat is produced from animals when milk production or work becomes unsustainable. In recent years, meat has gained more importance due to its export potential and domestic consumption. Due to the fast growing life style of urbanization, most of consumers purchase the meat in fresh form because they hardly find time to purchase daily fresh meat. Therefore, they purchase the meat in bulk quantity to meet their daily necessities and stored in freezer or refrigerator and consume after certain intervals. Hence the present study was designed to evaluate the effect of chilling, freezing and repeated-thaw cycles on chemical quality of various meats. The influence of different time was observed on chemical characteristics of chilled, frozen and thawed meat against fresh meat. Proximate composition such moisture, protein, fat, ash and glycogen decreased with increasing storage period of chilled, frozen and thawed buffen, chevon and chicken meat samples. Nutritive values of chilled, frozen and thawed buffen sample also decreased with increasing storage period.

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Key words
Buffen, Low temperature, Chemical attributes, Chevon, Preservation

INTRODUCTION

Globally, meat is a major portion of diet with strong implications in human health, economy and culture (Pighin *et al*., 2016). Production of meat includes various domestic animals, depending on factors like religious, cultural beliefs, convenience and availability (Paredi *et al*., 2013). These animals include sheep, buffalo, goat, camel, cow, and some other wild animals i.e. hog, dear and rabbit (Arain *et al*., 2010). It is well recognised that meat has high biological value with numerous key nutritional factors, like proteins, lipids, vitamins and trace elements (Zhang *et al*., 2010). Beside these, it is also a valuable source of vitamin B-complex including riboflavin, biotin, thiamin, pyridoxine, niacin, cyanocobalamin pantothenic and minerals like phosphorus, iron, selenium and zinc (Pereira and Vicente, 2013). Intrinsic properties of meat quality such as tenderness, texture, colour, juiciness, flavour and odour and as well as its nutritional characteristics of meat depend on, livestock practices, genetics, slaughter processes, storage conditions and animal feeding (Hocquette *et al*., 2012).

Preservation is the method or process of keeping something valuable alive, intact, or free from damage and the preservation of meat is the process of maintaining the quality of the meat for a period of time. For the development and rapid growth of supermarkets, meat preservation is essential to transport meat over long distances without compromising the texture, colour and nutritional value of meat (Nychas *et al*., 2008). The traditional methods of meat preservation are such as drying, smoking, desalination, fermentation, refrigeration and canning, and these have been replaced by new preservation techniques such as chemical, bio-preservative and non-heating method. The purpose preservation is to prevent the microbial damage and to reduce oxidation and enzymatic activity (Pal and Devrani, 2018).

Bearing in mind the perishable nature of meat and health perspective of consumers, the present study was designed to evaluate the low temperature preservation techniques and post thawing influence on chemical attributes of buffen, chevon and chicken meat.

MATERIALS AND METHODS

Collection of samples and preservation

Meat (buffen, chevon and chicken) samples (n=

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10 of each) were collected from Tandojam market and brought to the laboratory of Animal Products Technology for further analysis. Meat samples were divided into four groups i.e. Group-1 control, Group-2 chilled at 2 to 4°C, Group-3 frozen at -15 to -20°C and Group-4 thawed at room temperature. All these samples were analysed for their chemical properties. Group 1 was analysed on zero day of collection, while samples from Group 2, Group 3 and Group 4 were analysed up to deterioration.

Chemical analysis

Moisture content, protein content, fat content and ash contents was determined according to the methods, as described by AOAC (2000), Kjeldhal method, soxhlet extraction method and gravimetric method, respectively. Furthermore, glycogen content of meat samples were determined according to Kemp *et al*. (1954).

Nutritive value

Nutritive values were analysed on the base of following formula.

K.cal (per 100g) = [(% protein) (4)] + [(% fat) (9)] + (% Carbohydrates) (4)]

Statistical analysis

The obtained data was analysed statistically with computerized statistical package i.e. Student Edition of Statistix (SXW), version 8.1 (Copyright 2005, Analytical software, USA).

RESULTS

Moisture content

Table I shows the effect of low temperature preservation and thawing of frozen chicken meat on moisture content of buffen, chevon and chicken meat. The results showed that the moisture content in fresh buffen, chevon and chicken meat samples were 75.65%, 74.60% and 72.70%, respectively. However, in chilled meat with the passage of time the moisture content was decreased gradually. On 15th day the moisture content was 61.83%, 60.45% and 59.19%, respectively in buffen, chevon and chicken. In frozen meat the moisture content in buffen, chevon and chicken meat was 70.71%, 69.45% and 68.43% after 15 days and 65.44%, 64.11% and 63.33% on 30th day. In thawed meat, the moisture content was 61.22%, 60.88% and 58.65%, respectively, in buffen, chevon and chicken. It was observed that moisture percentage of chilled, frozen and thawed meat was significantly decreased as storage period increased in all groups.

Protein content

Table II shows the effect of low temperature and thawing of frozen chicken meat on protein content of buffen, chevon and chicken meat. The protein content of different samples groups decline as storage time of meat increased. In control sample, protein content of buffen, chevon and chicken meat was noted as 78.53%, 82.27% and 82.96%, on DMB (dry matter base), respectively. In chilled meat the protein content was 55.09%, 60.54% and 64.92% after 3 days and 23.95%, 26.17% and 33.69% after 15 days, respectively. In frozen meat, protein content was 74.67%, 79.38% and 80.40% after 3 days and 35.65%, 34.86% and 39.08%, on DMB after 30 days, respectively. In thawed meat, the protein content of buffen, chevon and chicken meat was reduced from 65.26%, 71.23% and 70.26%, on DMB 03rd day to 23.49%, 28.60% and 29.60%, on DMB 30th day, respectively. Results indicate that protein content of chilled, frozen and thawed meat decreased with passage of time.

Table I. The moisture content (%) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
0	Buffen	75.65^{a}	-	-	-
	Chevon	74.60^{ab}	-	-	-
	Chicken	72.70^{cde}	-	-	-
03	Buffen	-	70.45^{fgh}	74.65^{ab}	73.63^{bc}
	Chevon	-	69.92^{ghij}	73.71^{bc}	72.54^{cde}
	Chicken	-	68.76^{ijklm}	71.84^{def}	70.04^{ghi}
05	Buffen	-	67.22^{nop}	73.32^{bcd}	72.35^{cde}
	Chevon	-	66.29^{pqrs}	72.38^{cde}	71.43^{efg}
	Chicken	-	65.22^{rst}	70.54^{fgh}	69.46^{hijkl}
10	Buffen	-	64.38^{tuv}	72.32^{cde}	71.66^{ef}
	Chevon	-	63.44^{uvw}	71.45^{efg}	70.54^{fgh}
	Chicken	-	62.22^{wxy}	69.63^{hijkl}	68.23^{klmn}
15	Buffen	-	61.83^{xy}	70.71^{fgh}	69.69^{hijk}
	Chevon	-	60.45^{z}	69.45^{hijkl}	68.14^{lmno}
	Chicken	-	59.19^{z}	68.43^{jklmn}	66.69^{opqr}
20	Buffen	-	-	69.69^{hijk}	67.22^{nop}
	Chevon	-	-	68.32^{klmn}	66.46^{pqr}
	Chicken	-	-	67.68^{mnop}	64.88^{stu}
25	Buffen	-	-	67.02^{nopq}	64.74^{tuv}
	Chevon	-	-	66.32^{pqrs}	63.35^{uvwx}
	Chicken	-	-	65.56^{qrst}	61.74^{y}
30	Buffen	-	-	65.44^{rst}	61.22^{y}
	Chevon	-	-	64.11^{tuv}	60.88^{yz}
	Chicken	-	-	63.33^{vwx}	58.65^{z}

LSD (0.05) = 1.5343; SE ± = 0.7715

Table II. The protein content (% on DMB) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
0	Buffen	78.53^{b}	-	-	-
	Chevon	82.27^{ab}	-	-	-
	Chicken	82.96^{a}	-	-	-
03	Buffen	-	55.09^{lmno}	74.67^{c}	65.26^{gh}
	Chevon	-	60.54^{ijk}	79.38^{ab}	71.23^{cde}
	Chicken	-	64.92^{gh}	80.40^{ab}	70.26^{def}
05	Buffen	-	44.63^{tu}	68.33^{efg}	60.58^{ijk}
	Chevon	-	48.71^{qrs}	72.48^{cd}	64.89^{gh}
	Chicken	-	53.65^{mnop}	72.13^{cd}	67.15^{fg}
10	Buffen	-	34.03^{xy}	62.83^{hi}	54.52^{lmnop}
	Chevon	-	36.73^{vwx}	67.67^{efg}	58.49^{ijk}
	Chicken	-	43.86^{tu}	67.63^{efg}	62.20^{hij}
15	Buffen	-	23.95^{z}	57.77^{jkl}	46.92^{rs}
	Chevon	-	26.17^{z}	60.39^{ijk}	51.26^{opqr}
	Chicken	-	33.69^{xy}	60.56^{ijk}	55.30^{klmn}
20	Buffen	-	-	52.29^{nopq}	40.05^{uv}
	Chevon	-	-	55.02^{lmno}	44.75st
	Chicken	-	-	56.87^{klm}	49.94^{qrs}
25	Buffen	-	-	42.51^{tu}	32.50^{y}
	Chevon	-	-	46.88st	36.07^{wxy}
	Chicken	-		50.12^{pqr}	40.98^{uv}
30	Buffen	-	-	35.65^{wxy}	23.49^{z}
	Chevon	-	-	34.86^{xy}	28.60^{y}
	Chicken	-	-	39.08^{vw}	29.60^{y}

LSD (0.05) = 3.7077; SE ± = 1.8645

Fat content

Table III shows the effect of different preservation and thawing temperature on fat content of buffen, chevon and chicken meat. In fresh buffen, chevon and chicken meat, fat content was 9.93%, 8.57% and 7.94%, on DMB, respectively. The fat percentage of chilled buffen, chevon and chicken meat was 7.41%, 6.95% and 6.56% on day 3 and 4.03%, 3.77% and 3.46%, on DMB, respectively on day 15. In frozen meat it was recorded as 9.51%, 8.25% and 7.67% on day 3, 7.55%, 6.45% and 6.15% on day 15 and 5.32%, 4.65% and 4.47%, DMB after thirty days of storage, respectively. In each cycle of thawed meat, fat content on day 3 was 8.72%, 7.87% and 7.18%; and 4.33%, 4.43% and 3.85% on DMB on day 30. There was a significant difference in each meat in every interval of storage from 3rd day to 30th day of thawed storage and also there was a significant variation in each storage time interval.

Table III. The fat content (% on DMB) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
0	Buffen	9.93^{a}	-	-	-
	Chevon	8.57^{c}	-	-	-
	Chicken	7.94^{efg}	-	-	-
03	Buffen	-	7.41^{hij}	9.51^{b}	8.72^{c}
	Chevon	-	6.95^{klmn}	8.25^{d}	7.87^{fg}
	Chicken	-	6.56^{o}	7.67^{gh}	7.18^{jk}
05	Buffen	-	6.07^{q}	8.81^{c}	8.07^{def}
	Chevon	-	5.75^{rst}	7.68^{gh}	7.32^{ij}
	Chicken	-	5.32^{uv}	7.16^{jkl}	6.87^{lmn}
10	Buffen	-	4.94^{wx}	8.24^{de}	7.45^{hij}
	Chevon	-	4.60^{x}	7.15^{jkl}	6.72^{mno}
	Chicken	-	4.29^{y}	6.65^{no}	6.17^{pq}
15	Buffen	-	4.03^{y}	7.55^{hi}	6.66^{no}
	Chevon	-	3.77^{z}	6.45^{op}	6.03^{qr}
	Chicken	-	3.46^{z}	6.15^{pq}	5.67st
20	Buffen	-	-	6.99^{klm}	5.89^{qrs}
	Chevon	-	-	5.93^{qrs}	5.49^{tu}
	Chicken	-	-	5.72st	5.21^{uvw}
25	Buffen	-	-	6.09^{q}	5.08^{vw}
	Chevon	-	-	5.34^{uv}	4.69^{x}
	Chicken	-	-	5.14^{vw}	4.44^{y}
30	Buffen	-	-	5.32^{uv}	4.33^{y}
	Chevon	-	-	4.65^{x}	4.43^{y}
	Chicken	-	-	4.47^{y}	3.85^{z}

LSD (0.05) = 0.3070; SE ± = 0.1544

Ash content

Table IV shows the ash content of fresh, chilled, frozen and thawed buffen, chevon and chicken meat at the various intervals for thirty days. Ash content in fresh buffen, chevon and chicken meat samples was 6.73%, 4.21% and 5.46%, on DMB respectively, while in chilled treatment of storage, the ash content was 4.67%, 2.96% and 3.91% on day 3 and 2.23%, 1.21% and 1.69%, on DMB, respectively on day 15. After frozen treatment, these content were as 6.11%, 4.11% and 5.11% on day 3 and 2.58%, 2.26% and 1.61%, on day 30, respectively. In thawed meat, ash was 5.42%, 3.71% and 4.57% on day 3 and 2.24%, 1.21% and 1.35%, on DMB on day 30 respectively. Results indicate that ash content of chilled, frozen and thawed meat decreased with passage of time.

Table IV. The ash content (% on DMB) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
0	Buffen	6.73^{a}	-	-	-
	Chevon	4.21^{hij}	-	-	-
	Chicken	5.46^{c}	-	-	-
03	Buffen	-	4.67^{fg}	6.11^{b}	5.42^{c}
	Chevon	-	2.96^{rst}	4.11^{ijk}	3.71^{lmn}
	Chicken	-	3.91^{jkl}	5.11^{de}	4.57^{g}
05	Buffen	-	3.69^{lmno}	5.28^{cd}	4.92^{ef}
	Chevon	-	2.17^{x}	3.55^{mnop}	3.40^{opq}
	Chicken	-	2.96^{rst}	4.58^{g}	4.26^{hi}
10	Buffen	-	2.81^{tuv}	4.77^{fg}	4.48^{gh}
	Chevon	-	1.64^{y}	3.19^{qrs}	3.05^{rst}
	Chicken	-	2.14^{x}	4.12^{ij}	3.81^{klm}
15	Buffen	-	2.23^{wx}	4.20^{hij}	3.93^{jkl}
	Chevon	-	1.21^{z}	2.75^{tuv}	2.61^{uvw}
	Chicken	-	1.69^{y}	3.67^{lmnop}	3.42^{nopq}
20	Buffen	-	-	3.76^{lm}	3.39^{opq}
	Chevon	-	-	2.43^{xy}	2.21^{wx}
	Chicken	-	-	3.37^{pq}	3.02^{rst}
25	Buffen	-	-	3.21^{qr}	2.89^{stu}
	Chevon	-	-	2.11^{xy}	1.77^{y}
	Chicken	-	-	2.85^{tuv}	2.40^{wx}
30	Buffen	-	-	2.58^{vw}	2.24^{wx}
	Chevon	-	-	2.26^{wx}	1.21^{wx}
	Chicken	-	-	1.61^{yz}	1.35^{z}

LSD (0.05) = 0.3070; SE ± = 0.1544

Glycogen content

Table V shows glycogen content of fresh, chilled, frozen and thawed buffen, chevon and chicken meat. In the fresh buffen, glycogen level was 4.81% on DMB. In chilled buffen it was 3.42% on day 3 and 1.57% on DMB on day 15, respectively. In frozen meat, glycogen level was 4.58% on day 3 and 2.31% on DMB (dry matter base), respectively, on 30th day. Whereas in thawed buffen, it was 4.32% on day 3 and 1.93% on DMB on day 30. Glycogen level in results indicates that as time period increased, glycogen level was decreased. Based on ANOVA results, it was found that the glycogen level of different treatments were different significantly (P≤0.05) from one another.

Nutritive value

Table VI shows that the nutritive value was 422.73 k.cal/100g, 425.97 k.cal/100g and 417.82 k.cal/100g, on DMB in fresh buffen, chevon and chicken meat samples respectively. The calorific value of various chilled meats was 300.73, 318.79 kand 329.36 k.cal/100g on day 3 and 138.35, 145.89 and 171.50 k.cal/100g on DMB, respectively on day 15. In frozen treatment of meat, it was calculated as 402.59, 410.77 and 404.39 k.cal/100g on day 3 and 199.72, 191.45 and 203.43 k.cal/100g on DMB respectively after thirty days. Whereas in thawed seven cycles of buffen, chevon and chicken meat samples, calorific value was 356.80, 373.67 and 358.34 k.cal/100g on day 3 and 140.65, 163.59 and 160.29 k.cal/100g on DMB, respectively after 30 days. Results revealed that calorific value of chilled, frozen and thawed meats was decline as storage period increased.

Table V. The glycogen content (% on DMB) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
	Buffen	4.81^{b}	-	-	-
0	Chevon	4.94^{a}	-	-	-
	Chicken	3.63^{j}	-	-	-
	Buffen	-	3.42^{l}	4.58^{c}	4.32^{e}
03	Chevon	-	3.52^{k}	4.75^{b}	4.48^{d}
	Chicken	-	2.66^{qr}	3.44^{kl}	3.17^{mn}
	Buffen	-	2.65^{qr}	4.20^{f}	3.94^{h}
05	Chevon	-	2.70^{qr}	4.38^{e}	4.10^{g}
	Chicken	-	2.13^{v}	3.19^{mn}	2.94^{op}
	Buffen	-	2.13^{v}	3.90^{h}	3.63^{j}
10	Chevon	-	2.30^{u}	4.10^{g}	3.77^{i}
	Chicken	-	1.72^{x}	2.96^{op}	2.61^{rs}
	Buffen	-	1.57^{y}	3.52^{k}	3.10^{n}
15	Chevon	-	1.82^{x}	3.67^{j}	3.26^{m}
	Chicken	-	1.40^{z}	2.69^{qr}	2.28^{u}
	Buffen	-	-	3.17^{mn}	2.68^{qr}
20	Chevon	-	-	3.38^{l}	2.89^{p}
	Chicken	-	-	2.48t	2.02^{w}
	Buffen	-	-	2.73^{q}	2.33^{u}
25	Chevon	-	-	3.00^{o}	2.48^{qr}
	Chicken	-	-	2.18v	1.70^{p}
	Buffen	-	-	2.31^{u}	1.93^{w}
30	Chevon	-	-	2.54st	2.33^{u}
	Chicken	-	-	1.72^{x}	1.51^{y}

LSD (0.05) = 0.3070; SE ± = 0.1544

Table VI. The calorific/nutritive value (% on DMB) of fresh, chilled, frozen and thawed meat with time interval.

Time interval (days)	Meat	Fresh	Chilled	Frozen	Thawed
0	Buffen	422.73^{a}	-	-	-
	Chevon	425.97^{a}	-	-	-
	Chicken	417.82^{ab}	-	-	-
03	Buffen	-	300.73^{ik}k	402.59^{b}	356.80^{def}
	Chevon	-	318.79^{hi}	410.77^{ab}	373.67^{c}d
	Chicken	-	329.36^{gh}	404.39^{b}	358.34^{cdef}
05	Buffen	-	243.75^{opq}	369.41^{cd}e	330.71^{gh}
	Chevon	-	257.39^{nop}	376.56^{c}	341.84^{fg}
	Chicken	-	271.00^{mn}	365.72^{cd}e	342.19^{fg}
10	Buffen	-	189.10^{wx}	341.08^{fg}	299.65^{jkl}
	Chevon	-	197.52^{vw}	351.43^{ef}	309.52^{ij}
	Chicken	-	220.93^{stu}	342.21^{fg}	314.77^{hij}
15	Buffen	-	138.35^{z}	313.11^{hij}	260.02^{no}
	Chevon	-	145.89^{z}	314.29^{hij}	272.35^{mn}
	Chicken	-	171.50^{xy}	308.35^{ij}	281.35^{lm}
20	Buffen	-	-	284.75^{klm}	223.93^{rst}
	Chevon	-	-	286.97^{klm}	239.97^{pqr}
	Chicken	-	-	288.88^{klm}	254.73^{nop}
25	Buffen	-	-	235.77^{qrs}	185.04^{wx}
	Chevon	-	-	247.58^{opq}	196.41^{vw}
	Chicken	-	-	255.46^{nop}	210.68^{tuv}
30	Buffen	-	-	199.72^{vw}	140.65^{z}
	Chevon	-	-	191.45^{w}	163.59^{y}
	Chicken	-	-	203.43^{uvw}	160.29^{y}

LSD (0.05) = 0.0478; SE ± = 1.5869

DISCUSSION

With the long period of storage in chiller, freezer and freeze thawed meat, moisture content of buffen, chevon and chicken meat significantly decline. These findings agree with the Naveen *et al.* (2016), who indicated that the overall average moisture percentage in sausages of duck meat decreased during refrigerated/chilled storage for fourteen days. This may be due to the loss of drip during the storage and the evaporation of liquid from the meat in the refrigerator. The declining trend of moisture content during the refrigerated/chilling storage recorded in the current research is consistent with the findings of Biswas *et al.* (2011) in chicken meat loaves and in duck patties. And also in buffalo meat sausages which are kept in chilling conditions (Abdolghafour and Saghir, 2014). Consequently, Kondaiah *et al.* (1986) reported that the percent of moisture in frozen meat (beef) decline as storage period increased. The noticeable loss moisture percentage in the advancement of storage time may be due to alteration of myofibrillar in the frozen meat which may cause decline in capability water retention in meat (Kandeepan and Biswas, 2007).

Protein percentage of buffen, chevon and chicken meat decreased in various groups of meat with increase in period of storage. In chilled meat, the reduced protein percentage may be due to higher bacterial load which lead to greater activity of water and increased autolysis by enzymes in meat (Rao *et al.*, 1998). These results also agreed with the results of Kandeepan and Biswas (2007) who stated that buffen kept for in the refrigerator (4 ± 1°C) for four days displayed significantly lower protein content than meat stored in the freezer (-10 ± 1°C). Additionally, it was found that the protein content in seventh day of cold meat was lower than in the seventh and fourteenth day of meat stored in the freezer. However, protein loss in meat significant ($p < 0.05$) occur on thirtieth, sixtieth and seventy fifth day of frozen storage. This steady loss in advanced of experiment may be due to ice crystal formation in muscle tissue which results increased the solute concentration in muscle. Further Hammad *et al.* (2019) also observed that the effect of storage on crude protein in beef meat resulted in protein 17.50%, 15.40%, and 15.00%, respectively, and in poultry meat resulted in protein of 18.20%, 17.60%, and 16.70%, respectively, at -20°C during his study. Hammad *et al.* (2019) stated that the poultry contained more portion of protein ($P < 0.05$) in meat than buffen and the percent of protein obtained during this research was declining, which may be associated with the denaturation of meat protein during the frozen storage. Storage of meat in freezer stimulate the protein carboxylation and the development of schiff bases of chicken meat. Both thawing and freezing storage have effect on the activity of proteolytic (endogenous) enzymes, which is responsible for the breakdown of meat protein and the relaxation of structures of meat tissues (Utrera *et al.*, 2013).

Fat content of meat was decreased as the time of storage advanced in freezer and chiller. The meat fat is responsible for the species specific flavor present in the meat products. The clear difference in chilled meat sample might be due to the strong light exposure in display cabinets such as freezer and refrigerator, which enhanced the oxidation of fat and causing decline in fat percentage (Kandeepan and Biswas, 2007). This deterioration of fat in meat took place due to intermediary endogenous enzymes activities which leading to hydrolysis of meat fat. Kandeepan and Biswas (2007) also reported that the content of fat on the seventh

day of chilled meat significantly ($p<0.05$) changed with the percentage of frozen on the same day of storage. There was a steady decline in fat percentage on seventh and fourteenth day of buffalo meat during storage. Similarly, Hammad *et al*. (2019) observed that the crude fat content of beef and poultry meats decreased at half-shelf life. Fat content decreased from 4.83% to 3.00% in beef meat during the 2, and 4.5 months storage. Poultry meat showed a decrease in crude fat content from 7.63% to 6.90%. This variation in fat percentage during the frozen storage up to four and half months might be connected with the fat hydrolysis. Furthermore, these results also corroborate with findings observed by the Soyer *et al*. (2010). Nannur *et al*. (2017) reported that about 6.98% of fat was extracted from fresh cooked beef sample which was highest among all other samples. The loss of lipid content in the refrigerated storage samples is mainly considered to be related with auto-oxidation of lipids (Sampaio *et al*., 2012). Furthermore, Sabow *et al*. (2016) and Soyer *et al*. (2010) also reported that refrigeration storage has significant influence on lipid and protein oxidation resulting in loss of fat. This is the agreement with the findings reported by Maqsood *et al*. (2015). They said that decrease in total fats in meat during refrigeration storage is could be due to changing in the triglycerides levels.

Ash is the powdery residue left after the burning of a substance. Kandeepan and Biswas (2007) reported that there is gradual decline in ash content as storage period increase in buffalo meat. Okeyo *et al*. (2009) also reported that in frozen Nile perch, ash percentage decline with storage time in freezer. Nannur *et al*. (2017) stated that the ash percentage of all meat samples was almost same. Further this study is also correlated with Hammad *et al*. (2019), who stated that there was gradual decline in ash content as storage period increased in beef and chicken meat. Ivanovic *et al*. (2012), further stated that, the percentage of ash in fresh and frozen chicken meat was (1.00 and 2.10%), respectively, and these values were different than the ash content in the chest muscle meat and thigh chicken meat from (1.30 and 1.08%), respectively, which was comparable to the percentage obtained from the percentage of ash in chicken meat was (1%), and this percentage was less than the ash content in chicken meat (1.24%). Additionally, Augustynska-Prejsnar *et al*. (2018) reported that the continued storage in freezing can cause decline in the ash percentage. The reduction in ash content may be due to increased meat drip during the process of thawing, hence the subsequent loss of mineral salts increased.

In this study, the glycogen content of chilled, frozen and thawed buffen, chevon and chicken meat showed decreased trend with increased storage period of meat. Dave and Ghaly (2011) reported that during cold storage of muscle, glycogen is changed into lactic acid due to presences of amylolytic enzymes are responsible which cause gradual decline in glycogen of muscle. Rahman *et al*. (2015) also reported that in the anaerobic conditions glycogen of muscle also breakdown into lactic acid which also cause decrease of muscle glycogen during storage. Onopiuk *et al*. (2016) showed in obtained results that the muscles from commercial crossbred bulls, with higher glycogen levels measured at 2 h post-slaughter had higher lactic acid content, which indicates a higher degree of meat tissue acidification. Furthermore, Zelechowska *et al*. (2012) demonstrated that the reduced water binding capacity and resultant cooling loss are higher when the pH of meat is lower which cause reduction in glycogen of meat.

Kandeepan and Biswas (2007) also observed the various macronutrients during the low temperature preservation of beef meat, from his results it was noted that there was quit decrease in various macronutrients of beef, which indicate that there was decrease in calorific/nutritive value during the cold storage. Nannur *et al*. (2017) reported in his study that during the cold storage of cocked beef, there was a decline in proximate composition of meat, which cause decrease in nutritional quality of meat. The calorific/nutritive value of meat showed decreased trend with increase storage period of chilled, frozen and thawed buffalo meat. Rao *et al*. (1998) reported that nutritive/ calorific value decreased trend with increased bacterial growth which resulted higher water activity and enzymatic autolysis of meat. Apart from this deterioration of fat in meat took place due to intermediary enzymatic activities (hydrolysis of lipids) which cause decline in calorific/ nutritive value of meat (Kandeepan and Biswas, 2007). Hammad *et al*. (2019) indicted in his study that in chicken meat has higher values in macronutrients as compare to beef meat, which also indicated that chicken meat has higher percentage of calorific/nutritive value as compared to beef meat. Furthermore, he also observed effect of freeze and re-freeze the chemical composition of beef and poultry meat at storage period, from the results it was observed that there was decline in macronutrients in both meats, which also indicated that during the storage there was a decrease in calorific/ nutritive values.

CONCLUSIONS

It is concluded that low temperature treatment have effect on meat quality with the passage of time. Here it was observed that in chemical attributes such as, moisture, protein, fat, ash and glycogen decreased with the increase of storage time. It is recommended that in chilled storage

meat quality is good up to five days, in frozen storage meat can be utilized up to 25 days while thawing cycles up to four are suitable for human consumption. Beyond these meats unfit for human consumption due to low quality.

Statement of conflict of interest

The authors have declared no conflict of interest.

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