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Determination of Chemical Content and some Physical Properties and Meat Pigments (Myoglobin, Meta Myoglobin and Oxymyoglobin) in Different Parts of Slaughtered Animals

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Abstract: The current study aimed to estimate the pigments of some muscles parts taken from cows, sheep and chicken (thigh, chest and back). The chemical content including moisture, protein, lipids and ash, as well as the pH and the water holding capacity have been evaluated. Results showed that the moisture differed among three animals with high percentage of moisture, ash and lipid in back in compared with other parts of cows. while significant difference in the percentage of ash of back with other parts and in protein in chest with other parts of sheep. The significant differences were recorded in percentage of ash of three parts of chicken, also significant differences between chest and back. The water holding capacity of fresh meat samples taken from thigh, chest and back of cows, sheep and chicken significantly differ among samples. pH values which reflect a confect in water holding capacity of meat samples taken from different parts of the body and from different animal. In addition, there was a significant differences in the percentage of the presences of myoglobin, metmyoglobin and oxymyoglobin in different samples taken from different parts of the slaughtered animals.

Keywords: chemical content, physical properties, Myoglobin, Oxymyoglobin, slaughtered animals.

Introduction

Meat can be defined as that type of animal tissue that could be eaten or represent in the animal tissue that undergo basic viable changes after the death of the animal and become suitable as a food, this kind of tissue can be obtained from farm animal (cows, sheep, goats and camel) in addition to chicken and fishes (USDA, 2004).

Meat considered as a high valuable nutrients that overrun others . The muscles consist of 60- 80 % proteins with a high biological value, as well as containing lipids which have a role in metabolism in particularly unsaturated fatty acids, cholesterol, phospholipids and the soluble vitamins. Lipids contribute in elevating the nutrition value of meat because it have high calories and represent 1% of the daily nutrients needs for human. Muscles also contains minerals and vitamin group B, as many of the vital events within the body. Volitional movements need essential amino acids to sustain life which meat considered to be the most important source of it (Aberle *et al.*, 2001; Gimenez *et al.*, 2011). White and Red meat are considered one of the most palatability food and the country's economic progress measured by their meat consumption, as it has a very high nutritional

value due to its contents of proteins, lipids, vitamins and minerals (CFIS, 2004; Michaelsen *et al*., 2009).

Proteins are the major component of muscles contentand they characterized by their unique physiological function of muscle contractions and responsible of the actomyosin complex that results from the union of myosin and actin which affect the freshness of the meat (Al-Taii, 1987; Boland *et al.,* 2018).

Many factors affect the chemical and physical features of meat such as species, genus, size, physiological status, sexual maturation and nutrition of animal (Inoue & Ishikawa, 2000). pH is one of most important factors which indicates the quality of meat and determine the length of time to store the meat. pH also counted to measure the ability of meat to water holding capacity and the liquid exudation when dissolving the samples .The most important factor affecting pH in meat after slaughtering the animal is the decomposition of glycogen and the accumulation of lactic acid. pH also affected by other factors including how the animal will results in consuming most of the glycogen resultant in high pH value. Briskey & Collegues (1971) found that the pH was 6.18 after 4.5 hours of slaughtering and the color of muscle was dark red . Additionally, It also be affect by the environment factors, animals when are at high temperature led to accelerate of the loss of energy of animal slain resulted in low pH at short time (Lawrie, 1979). The type of the animal is also affect the pH value. Al-Hisnawi *et al.* (2010) reported that the pH of fresh beef, buffalo, sheep and camel were 5.1, 5, 5.8 and 5.6, respectively, at the same storage circumstances in the long back muscle, while the type of muscle have no effect on the pH value. Shehate *et al*. (1970) and Zhen Qin & Liu (2017) noticed the pH in fresh long back muscle in cows was 6.4 and this value decreased significantly to 5.4 with cooling effect in refrigerator for 10 days. After that it drops to 5.2 with storage using freezing for 90 days (-10º). Agena (2001) demonstrated that the pH value of beef meat decreased after freezing for 90 days but then it increased.

One of the other factors is the water holding capacity which related to meat clemency, the water holding capacity affects the appearance of the meat. High temperatures lead to a remarkable change in the protein nature and to decrease the ability to hold water. On the other hand, the fast decrease in the pH will accelerate the loss of moisture during meat manufacturing (Al-Zalaki, 2006). The loss of water in good quality meat is insignificant compared with low quality meat. (Al-Shfea, 2002). The red colour of meat is considered one of the important features because of the myoglobin, the myoglobin is an essential pigment that contributes in determination of the colour. The colour strength depends on the pigment concentration, myoglobin contribution is differs according to the amount of muscle and the type of animals, the appearance of meat to the consumer doesn't depend on the amount of myoglobin only, but also on the type of it's molecular and the chemical condition for the other components of meat. This pigment is soluble in water and it is from the blood to the cell, this protein changes its colour from red to blue or brown or even green depending on its chemical status. Youny *et al*. (1988) showed that the fresh meat colour depends on reductive amounts of myoglobin reductive derives (reduced myoglobin), oxyoglobin and met myoglobin. Reduced myoglobin; it is the dominant pigment in muscles in case O_2 is

absent and gives purplish colour to meat during the cut.

Oxymyoglobin; it is the oxy form of myoglobin and it is responsible of meat bright red colour, in oxidative status; and responsible of the unwanted brown colour of meat which is rejected by the consumer. it is the main cause of fresh meat colour change (Al-Moussawi, 1995). It is obvious that the high activity of muscles needs more myoglobin and most importantly is the oxymyoglobin resulted in desirable red colour. If the myoglobin is bound to O_2 atom and was with drawl from it, by the exactly enzymes inside the cell. the colour change to dark blue which is metmyoglobin (Al-Tamimi *et al*., 2009). Under certain temper circumstances the myoglobin to intone compound is hemochrome which gives the meat a brown to gray colour which is the colour of meat after cooking. (F.S.I.S., 2007).

Materials & Methods

Raw Materials

This study was conducted using beef, sheep and chicken meat from thigh, chest, and back with one kg of each sample obtained from the markets of Basrah. The samples were collected from animal carcasses thigh, chest and back. The meat samples were then divided into three parts of the samples (fresh, cooled at 4ºC and frozen at -18ºC), and kept in polyethylene bags and stored for three days.

Working Methods

Chemical analysis were conducted for the following parameters:

1-Moisture

The percentage of moisture was estimated using 2 g of the sample after drying in oven type Menmmert Iranian origin at 105 ºC for 18 hours according to method of AOAC (1988).

$$\text{Moisture } \% = \frac{\text{the weight of the original sample\_ the sample after drying}}{\text{the weight of the original sample}} * 100$$

2-Protein

The total nitrogen ratio of all samples was estimated based on the method mentioned in

AOAC (2006) and using the microkjeldahle method. The conversion factor of 6.25 was used to extract the protein content of all meat samples.

3-Lipids

The percentage of lipid in meat samples was estimated according to the method of AOAC (2006), using soxolhelt extraction units. The extraction process took more the 18 hours using petroleum ether.

$$\text{Lipid } \% = \frac{\text{weight of lipid}}{\text{the weight of the sample}} * 100$$

4-Ash

The percentage of ash was estimated by burning the dried samples in Muffle Furnase type Cabolite at 525 ºC for 16 hour and repeating the weight of the ash until the weight stabilized according to the method mentioned in AOAC (2006).

$$\text{Ash } \% = \frac{\text{weight of ash}}{\text{weight of the sample}} * 100$$

Physical Properties

1-pH

The pH was measured according to John *et al*. (1975). The PH was estimated by taken 5 g of minced meat and adding 20 ml of

distilled water and mixed well in the blender for 5 minutes then filtration through cotton compressed.

2-Water Holding Capacity WHC

It was estimated by taking 10 g of minced meat and adding 20 ml of distilled water, mixed the sample well to obtain a homogeneous mixture using the electric mixer. Then the mixture transferred to a cylinder with a funnel at the end and a filter paper type 1 then receive the filter and register it after 30 minutes (Al-Taii & Al-Moussawi, 1992).

3-Myoglobin

The pigment of the myoglobin was calculated according to Zessin *et al.* (1961) using optical Spectroscopy. A sample of minced meat was taken 10 g and mixed with 90 ml of distilled water. The mixture was then filtered with medium permeability filtration and the pigment concentration was determined by reading the filtration density of the filter at length 525 nm and by pigment concentration according to the following equation:

$$\text{Myoglobin } \left(\frac{\text{mg}}{\text{g}}\right) = \frac{\text{the value of absorption } * \ 2.4}{\text{the weight of sample } * \ 0.452} * 100$$

- Where 0.452 represents the absorption factor a wavelength of 525 nm and 2.4 represents a coefficient mitigation .

4-Metamyoglobin

Metamyoglobin was measured by the method mentioned by Lee *et al*. (1998) by mixing 5g of minced meat with 25 ml of cool solution of phosphate deposition of 0.04 M with pH (6.8) and using homogenized device for a minute. Then samples left for one hour in the refrigerator at 5 ºC. The samples were centrifuged at 5000 rpm at 40 5ºC and filtered through a filtering paper 1 then the absorption was read at wavelengths of 525 nm, 572 nm and 700 nm using the optical spectrometer. The proportion of the pigment of metamyoglobin was calculated based on the equation mentioned in Krzywicki (1982).

$$\text{Metamyoglobin (Met – Mb) \%} = \ 1.39 - \frac{A700 - A\,572}{A\,700 - A\,525} * 100$$

The A700 represents the absorption value at a wavelength of 700 nm, the A572 represents the absorption value at a wavelength of 572 nm and the A525 represents the absorption value at a wavelength of 525 nm .

5-Oxymyoglobin

The estimation of Oxymyoglobin was performed in the different muscle parts of animals by method Broumand *et al.* (1958) and Al-Moussawi (1995), using optical spectroscopy. The Myoglobin was calculated according to the following equation .

$$Oxymyoglobin\ \% = (\text{Myoglobin \% } + \text{ Metamyoglobin\%}) - 100$$

Results & Discussion

Meat chemical Composition

Table (1) shows the chemical composition of the samples taken from the thigh, chest, and back areas of beef, sheep and chicken. Moisture, protein, fat and ash were 76.18, 76.14 and 70.33% moisture, 19.67, 19.65 and 18.02%, 3.30, 3.27 and 2.20% and 0.86, 0.87 and 0.44% respectively in the muscles of the parts taken from the cows, The percentage of the muscles taken from the sheep was

75.30 , 74.80 and 73.22) % moisture 20.70, 16.60 and 16.34 % protein, 3.80, 4.10 and 3.65% fat and 1.01, 1.13 and 1.76 % ash respectively, while the proportions of the parts of the chickens were 65.60, 67.50 and 64.87 %, while the percentage of protein 19.80, 19.70 and 18.88 %, fat percentage 1.37, 1.15 and 1.11 % and Ash 1.00, 10.2 and 1.76 % respectively.

The study found that the moisture in the muscle parts (thigh, chest and back) collected from cows was higher than the moisture content in the muscle taken from sheep and chickens. It was also noted that the percentage of protein in the sheep's thigh was higher than the protein in the thighs of cows and chickens, while the protein in the chest and back of chickens was the highest compared to the percentage of meat taken from the chest and back of cows and sheep. While the content of fats was high in the thigh muscles, chest and back taken from sheep (3.80, 4.10 and 3.65%) compared to the cows and chickens. Regarding the value of ash, it was found that the highest percentage was reported in the chest muscle and chicken back, while the percentage of the thigh muscle was close in sheep meat and chicken, and the lowest value was examined in the cow's thigh. It was examined that the moisture was within the limits (57 and 77.1%) and in a good agreement with Al-Hisnawi *et al.* (2010) in the fresh carcasses of cows; and Williams (2007) noted that the humidity in lamb meat at the age of three months was 72.90% and at the age of 10 months reached 73.20%; which is higher than the percentage obtained by Al-Awaimer & Al-Hawas (2003). They showed that the humidity in sheep was 72%. The results of the present study are similar to those of Owen *et al*. (1986) in their study on fresh chicken meat, with moisture of 65.82% in fresh samples.

Al-Ani (1999) reported that the moisture in the flesh of the old chicken thigh and chest at the age of 73 weeks was 68.84% and 70.78%,

Table (1): Chemical content in thigh, chest and back in cows, sheep and chicken.

Type of Meat	Muscles parts	Components%			
		Moisture	Protein	Lipid	Ash
Cows	Thigh	76.18	19.65	3.30	0.86
	Chest	76.14	19.65	3.27	0.87
	Back	70.33	18.02	2.20	0.44
Sheep	Thigh	75.30	20.70	3.80	1.01
	Chest	74. 30	16.60	4.10	1.13
	Back	73.22	16.34	3.65	1.76
Chicken	Thigh	65.60	19.80	1.37	1.00
	Chest	67.50	19.70	1.15	2.10
	Back	64.87	18.88	1.11	1.76
L.S.D.$_{0.05}$ for interaction		2.12	1.02	0.78	0.16

All the results in the table are triplicate mean

respectively, and these percentages are similar to the percentage of chicken meat moisture reported in the current study. This result is also consistent with the results of Jiang (1998), who pointed out that the moisture content of 75% in different types of animal vertebrates such as fish, birds and cattle also found Agena (2001) that the humidity was 75.75% in fresh veal, 76.14% fresh cow meat. The results were consistent with the Agena (2001) which indicated that proportion of protein in fresh veal was 19.80%. This percentage was found to be inconsistent with what Williams (2007) found. There was no significant difference in the effect of animal age on protein content in small calves and the large cows which were 24.80 and 23.20%, respectively. These protein percentages were lower than those found in Al-Hisnawi *et al*. (2010). It indicated that fresh meat collected from the cow's thigh with protein was about 23.19% and less than Rotta *et al*. (2009) when studying the protein percentage in three 10-year-old bull breeds month (24, 24.9, and 24.5%, respectively), but higher than Rahim (2003) when studying the chemical composition of the hip muscle of the elderly cattle (6 years old).

The result was agreed with Williams (2007), who reported that the protein content was not significantly affected by animal age. The protein content in the lamb meat at the age of three months was 21.90%. The 10 month age was 21.50%. The percentage of protein in the two-week-old sheep was 22.8%, but higher than the percentage reported in the same study. The researcher pointed out that the percentage of protein in the Arabian sheep at the age of two weeks was 18.7% and the month was 16.15%. Al-Marzani (2007) showed that the ratio of protein in raw sheep meat was 16.30%. These values are higher than those found by Sahasrabudhe *et al.* (1985). The percentage of protein in chicken meat was 24%, which is higher than that of Mohamed & Ahmed (2017) in chicken breast and thighs, which was 13.18 and 12.80 %. Which is lower than the protein content of the turkey and turkey mixture 20.22% (Al-Dulaimi *et al.,* 1991). Al-Ani (1999) showed that the proportion of protein in meat (thigh and chest) chicken 24 hours after slaughter was 23.32 and 24.9% respectively, or found Trogan *et al*. (1978). That the proportion of protein in Fresh chicken breast was 23.30%, but higher than Van Laack *et al.* (2000) found when it was estimated that the protein content in the flesh of the chicken breast after six hours of firing was 20.50 %.

The results of the study were similar to those obtained by Agena (2001), where the percentage of fat was 3.66% and 3.57% in calf and fresh beef, and Moon *et al.* (2015) reported that the fat percentage in the various muscle tissues of beef ranged from 1- 4.2%. This was confirmed by Williams (2007), where it was reported that the percentage of fat in the meat of small calves was 1.5% and in the meat of large cows was 2.8% as it increases the life of the animal and this percentage is less than found Al-Moussawi (1995), noting that the proportion of fat in beef was 1.27%. These values are similar to those found in Williams (2007), who reported that the fat content in lamb meat at the age of 3 months and sheep at the age of 10 months was 4.0 and 4.7% respectively, which is similar to the percentage mentioned by Moon *et al.* (2015). In the muscle tissue of different sheep ranged between 3.8-3.4%. The percentage of fat in chicken meat was lower than that of chicken breast and chicken thighs, which was 4.32 and 10.09% respectively Abid *et al*. (2009) which is less than 3% fat for chicken muscles (Suchy *et al*., 2002) In

the chicken muscles which contained 1.2% Al-Husseiny (2017).

The results of the present study are consistent with Lyon (1984) as well as Lamkey *et al*. (1986) who studied the percentage of ash in the fat-free beef shoulder strips, noting that the amount of mineral salts (ash) and in beef (3.5-5%) (Al-Hisnawi *et al.*, 2010). These percentages were higher than those found in Xiong (1997). The fat content of beef slices after 6 hours of slaughter was 1.28%, but higher than those found in Ray *et al*. (1984). Ash in pure red beef was 0.9%, the percentage of ash in sheep meat differed from the percentage of ash in fresh and frozen goat meat 1.03, 1.06, 1.2, 1.3 and 1.6%, indicated by Arain *et al.* (2010) when thy studied the composition of goat meat at the ages of 7, 8, 10 and 11 months.

The percentage of ash in the meat of the chicken muscles was higher than the ash percentage of 1.30 and 1.08% in the flesh of the chest muscle and the thigh of the chicken meat studied by Ivanovic *et al.* (2012), an approach to Pomeranz & Meloen (1977). The percentage of ash in chicken meat was 1% as it was similar to the ash ratio in chicken meat 1.24 % (Abid *et al*., 2009).

Physical properties of meat: pH and Water Holding capacity (WHC)

The pH values were calculated as follows: 5.63, 5.18 and 5.33, respectively (6.08, 6.24 and 6.06), and 5.53 (recorded in fresh beef, sheep and chicken from the thigh, chest and back) , 5.67, 5.43), respectively, while the pH values of beef, sheep and chilled chicken from the thigh, chest and back areas were as follows: (5.66, 5.25 and 5.47), respectively (6.27, 6.80 and 6.74) Respectively, and 5.88, 5.60 and 5.50 respectively. The pH values of cows, sheep and frozen chicken from the thigh, chest, and back areas were as follows: (5.30, 5.50 and 5.70) respectively, (6.84, 6.83 and 6.50) respectively (5.70, 5.90 and 5.61) respectively as shown in table (2).

The values of pH in the fresh, chilled and frozen parts of the sheep (thigh, chest and back) were higher than in the fresh, chilled and frozen muscle parts of cows and chickens.

These values were close to those of Soltanizadeh *et al*. (2008), indicating that the pH values were similar to the pH values obtained by Jose *et al.* (1984). In his analysis of samples of fresh beef from ribs, The pH values ranged from 6.64 to 6.67 and were also related to the pH values found by Al-Hisnawi *et al.* (2010). The value of pH was 5.71 in cow's thigh meat. (Brewer *et al.*, 1992), while Al-Moussawi (1995) found that the pH value of beef was 5.6, which approximates the current results as well as the beef. The values of pH were similar to those of Al-Aswad & Al-Dulaimi (1987), which showed that the pH value of the 7-month-old Hamdani sheep was 5.83. The results of the current study are in line with the results of Al-Dulaimi (1981).

The value of pH in fresh goat meat was 6.19 and in goat female it was 5.96. These values are similar to those reported by Al-Marzani (2007) that the value of pH in raw sheep meat was 5.25. It is similar to what Al-Dulaimi (1981) mentioned when the value of pH was 6.19 in goat meat if the animal was slaughtered and then decreased to 6.08 three hours after slaughter. Between Al-Dulaimi *et al.* (1991), the pH value in a mixture of fresh turkey and turkey meat was 6.10, higher than the pH value of chicken meat under study. These values are similar to those found in Schon & Ristic (1977), which indicated that the value of pH is 5.80 and that it remains constant after slaughter and during storage. Which is lower than the value of

pH 6.64 and 6.73 in old chicken breast and thigh (Al-Ani, 1999).

It is generally observed that the pH of different meat species tends to be acidic, due to the release of free fatty acids by lipids and phospholipids that remain effective (Andersson, 1980). One reason for the low pH may be the production of organic acids by bacteria (Incze, 1998). The difference in pH values may be due to differences in carbohydrate ratios in meat species and thus lead to variation in the amount of lactic acid formed which is responsible for the change in pH values. pH is an indirect measure of the extent of degradation in carbohydrate, Animal death and its transformation into lactic acid (Huss, 1988).

Table (2): pH values in (thigh, chest and back) of beef, sheep, fresh, chilled and frozen chicken.

Type of Meat	Muscles parts	pH		
		Treatments of fresh	Treatments of chilled	Treatments of freezing
Cows	Thigh	5.63	5.66	5.70
	Chest	5.18	5.25	5.50
	Back	5.33	5.47	5.30
Sheep	Thigh	6.08	6.27	6.50
	Chest	6.24	6.80	5.83
	Back	6.06	6.74	6.84
Chicken	Thigh	5.53	5.60	5.70
	Chest	5.67	5.88	5.90
	Back	5.43	5.50	5.61
L.S.D.$_{0.05}$ for interaction		0.35	0.54	0.65

All the results in the table are triplicate mean

We also note that the values of pH in meat were different, due to the difference in the percentage of nitrogen bases formed by protein degradation, the content of which is also different in the different samples taken from meat. These nitrogen bases are known to be responsible for the high pH values, (Cheng *et al.*,1989). Davey & Winger (1988) suggested that pH decline can be affected by the physiological state of the animal as well as by hunger and muscle stress before slaughter or the pH may rise above the normal limit due to the depletion of the glycogen.

Water holding capacity in fresh meat was measured and found to be (8.6, 8.1 and 8.3) ml for cow meat from thigh, chest and back areas, while sheep meat from thigh, chest and back were (7.6, 8.7 and 7.6) ml respectively, and chicken meat from the thigh, chest and back areas was found to be equal to (7.5, 7.6 and 7.4) ml, respectively. The values of the water holding capacity in the cooled samples were (7.7,_ 7.3 and 7.5) ml, (7.5, 7.5 and 7.0) ml;_ (7.7, 7.5 and 7.5) ml respectively of the muscle parts of the thigh, chest and back of the cows, sheep, and chickens. The values of

water holding capacity in the thigh, chest, and back areas of frozen cows were (7.0, 7.3 and 7.2) ml, but in the thigh, chest, and back areas of frozen sheep were (7.0, 7.2 and 7.8) ml, also in in the thigh, chest, and back areas of frozen chicken were (7.8 , 7.5 and 7.3) ml respectively (table 3).

Table (3): Values of water holding capacity in (thigh, chest and back) for beef, sheep, chicken of fresh, chilled and frozen.

Type of meat	Muscles parts	Water holding capacity		
		Treatments of fresh	Treatments of chilled	Treatments of freezing
Cows	Thigh	8.6	7.7	7.0
	Chest	8.1	7.3	7.3
	Back	8.3	7.5	7.2
Sheep	Thigh	7.6	7.5	7.0
	Chest	8.7	7.5	7.2
	Back	7.6	7.0	7.8
Chicken	Thigh	7.5	7.9	7.5
	Chest	7.6	7.5	7.3
	Back	7.4	7.5	7.2
L.S.D.0.05 for interaction		0.31	ns	ns

All the results in the table are triplicate mean

In the fresh samples, it was found that the values of water holding capacity was highest in the fresh sample of the sheep's breast 8.7 ml, and the values of water holding capacity increased in the muscle parts collected from the cows compared to the same in sheep and chickens. The cooled samples were found to have the highest value of the water holding capacity in the frozen samples, the highest water holding capacity in the dorsal muscle was 7.8 ml. The water holding capacity of all frozen samples was close to all meat parts of the meat and ranged between 7.0-7.5 ml. Values were comparable to water intake 9.74 and 14.54 ml for raw beef at natural pH and high pH (Zhang *et al*., 2005).

Farouk *et al.* (2003) found that the values of the water holding capacity of cow meat cooled for different periods 0, 3, 6 and 9 months were 11.98, 11.24, 12.64 and 11.82 ml, respectively, which is higher than the water holding capacity of the examined beef. It was observed that the water holding capacity of these sheep muscles was higher than that found by Wiegand *et al.* (2006). The water holding capacity of pork after 1, 14 and 28 days of cold storage after slaughter was 3.10, 2.77 and 2.59 , respectively. These values were lower than the water holding capacity of small lambs after 24 hours of firing time 7.46 ml (Abdel-Aal & Mohamed, 2011). Mendiratta *et al.* (2008) reported that the water holding capacity of the meat Sheep was 7.22 ml at pH = 6.83, which is high compared to the sheep's water holding capacity examined in the present study

(Abbas, 1979). The amount of water associated with local goat meat stored in the refrigerator at 4 °C after two hours and 3, 6 and 10 days, indicated that the water carrying capacity during cooling of these periods was 9.10 and 9.64 ml, respectively, which was also less than that of goat meat aged two and six months (7.32 and 7.75 ml, respectively, Stankov *et al.,* 2002).

In the meat of the fresh chicken muscles, the water holding capacity was close to the water holding capacity 2.22 ml for the meat, the chicken breast was 40 days after the slaughter directly and also the water holding capacity was 6.45, 6.82 and 6.77 ml when storing the refrigerant after one, four and seven days. These values are lower than those of Tamarkhan (2006). The water holding capacity was 13.81 and 13.61ml, respectively, in Turkey's breast and thigh 13.75 and 13.56 ml, respectively, in Brazilian chicken breast and thigh, 13.95 and 13.97 ml respectively in breast and chicken thigh (Dohuk).

The decreasing in water holding capacity is mainly due to the synthesis of lipid proteins, especially actin and myosin, and the cause of protein staining is due to the size of ice crystals and the increase in ionic strength due to crystallization of water and the oxidation of fats and proteins (Rosenvold & Andreson, 2003; Belitz *et al.,* 2004). The decrease in water holding capacity is due to the synthesis of lipid proteins, especially actin and myosin, and to the height of pH, which is affected by muscle stress before slaughter, and this is due to the depletion of the classics. When the pH reaches 5.5, the iso-electric point of the meosin and the pH of the muscles is less than the electrode, the amount of water associated with it is high for the animal's own muscles (Al-Taii & Al-Moussawi, 1992).

The difference in the water holding capacity of different meat is due to the difference in moisture content, since there is a relationship between moisture content in the muscles and the value of pH. The higher the pH value, the more water holding capacity (WHC)(Al-Taii, 1987).

Estimation of myoglobin, metamyoglobin and oxymyoglobin pigments

The results showed that the percentage of fresh meat from the thigh, chest and back areas was 34.09, 40.09 and 32.33 $mg.g^{-1}$, respectively, while, Thigh, chest and back were 30.11, 32.56 and 29.67 $mg.g^{-1}$, respectively, while the sheep meat from the thigh, chest, and back areas contained myoglobin with 20.11, 19.00 and 16.33 $mg.g^{-1}$, respectively. The results were as follows: 26.76, 36.66 and 27.74 $mg.g^{-1}$ respectively for cows and 26.33, 28.54 and 24.98 $mg.g^{-1}$ respectively for sheep and (16.33, 15.93 and 13.57) $mg.g^{-1}$ for chicken, while the results indicated that the values of myoglobin in the frozen muscle parts (thigh, chest and back) for cows, sheep and chicken were 21.28, 30.24 and 23.82 $mg.g^{-1}$ and 23.80, 25.83 and 20.53 $mg.g^{-1}$ and 13.33, 12.67 and 11.40 $mg.g^{-1}$, respectively.

The highest value of myoglobin in the fresh samples collected from different muscles of beef, sheep and chicken was in the femoral and thoracic muscle of cows which was 40.09 and 34.09 $mg.g^{-1}$, respectively, and the lowest percentage in the dorsal muscle of the chicken was 16.33 mg.

In the frozen samples taken from the different muscles of beef, sheep and chicken, the highest percentage of myoglobin in the musculoskeletal muscle was 36.66 $mg.g^{-1}$ and 30.24 $mg.g^{-1}$ respectively, while the percentage of pigment was similar in other muscle parts of cattle and sheep, but the

percentages were few in the parts taken from chickens, and it was found that the percentage of the pigment was decreased after the cooling and freezing of the samples as a result of loss of liquid perfusion.

Rohlik *et al*. (2013) found that the red colour of meat products depends on the concentration of the hem pigment which affected by the manufacturing process and the storage conditions. The unwanted reactions that occur are fat oxidation and unwanted colour change.

The results showed that the percentage of myoglobin of imported chicken meat ranged between 0.1 and 0.5 mg. g meat^{-1}. It also came in comparison with Al-Rubaie *et al.* (2007) who found that the percentage of myoglobin chicken meat at 4°C for 0, 3 and 6 days were 1.80, 1.67 and 1.55 mg.g^{-1} respect-ively (table 4).

Table (4): Concentration pigment myoglobin in (thigh, chest and back) of beef, sheep, fresh, chilled and frozen chicken.

Type of Meat	Muscles parts	Myoglobin (mg.g^{-1})		
		Treatments of fresh	Treatments of chilled	Treatments of freezing
Cows	Thigh	34.09	26.76	21.28
	Chest	40.09	36.66	24.30
	Back	32.33	27.74	23.83
Sheep	Thigh	30.11	26.33	23.80
	Chest	32.56	28.54	25.83
	Back	29.67	24.98	20.53
Chicken	Thigh	20.11	16.33	13.33
	Chest	19.00	15.93	12.67
	Back	16.33	13.57	11.40
L.S.D.0.05 for interaction		2.56	2.86	1.98

All the results in the table are triplicate mean

Al-Athari (2017) showed that the storage period had a significant effect (P <0.01) on the percentage of the myoglobin pigment in the minced meat tablets, which gradually decreased with the duration of storage by freezing. The decrease was more pronounced in the control sample at refrigerated storage.

The results showed that the percentage of metamyglobin in the fresh meat of the thigh, chest and back muscles was 64, 46 and 18% respectively. In the fresh meat of the thighs, chest and back, sheep were 42, 46 and 25% respectively, Metmyglobin in the fresh muscle segments (thigh, chest, and back) was 56, 77 and 33)%, respectively. In the chilled meat of the thigh, chest and back muscles of the cows were 73, 40 and 21%, respectively, and the chilled meat of the thighs, chest and back of the sheep was 47, 53 and 32%, respectively, and the proportion of

metmyglobin in the chilled muscle parts (Thigh, chest, and back). The chickens were 64, 83 and 46%, respectively. The frozen meat of the thigh, chest and back muscles of the cows was 78, 46 and 26% respectively, and the frozen meat of the thigh, chest, and back of the sheep was 51, 59 and 35% respectively. The ratio of Met myoglobin in the frozen muscle And chest and back were 70, 87, 50%, respectively.

The highest value of metmyoglobin in the fresh collected from different muscles of beef, sheep and chicken was in the femoral muscle of the cows which was 64%, while the percentage of pigment was in the dorsal muscle of the cows 18%. In the frozen and frozen samples collected from the different muscles of beef, sheep and chicken had the highest percentage of met myoglobin in chicken chest muscle which were 83% and 87%, respectively, while pigmentation ratios were close to other muscle parts of cattle, sheep and chickens.

Al-Athari (2017) indicated that the concentration of the meta-myoglobin in minced beef was 35.68 % and was close to the results highlighted in the current study.

Velasco & Williams (2011) showed that the colour of meat is one of the most important qualities adopted by the consumer to assess the quality of the meat and its temperament, and explained that the colour change of meat is due to the oxidation of the pigment of red oxymyoglobin to the unwanted brown myoglobin.

Salman & Saleh (2012) concluded that the reason for increasing in the percentage of the oxymyoglobin pigment during meat treatment or preservation is to oxidize the myoglobin pigment, as Fe^{+2} is converted into Fe^{+++} iron (Al-Taii, 1987).

Table (5): Concentration of Metamyglobin pigment in (thigh, chest and back) of fresh, chilled and frozen beef, sheep and chicken.

Type of Meat	Muscles parts	Metamyoglobin %		
		Treatments of fresh	of Treatments chilled	Treatments of freezing
Cows	Thigh	64	73	78
	Chest	46	40	46
	Back	18	21	26
Sheep	Thigh	42	47	51
	Chest	46	53	59
	Back	25	32	35
Chicken	Thigh	56	64	70
	Chest	77	83	87
	Back	33	46	50
L.S.D.$_{0.05}$ for interaction		2.34	1.88	3.67

All the results in the table are triplicate mean

The results showed that the ratio of oxymyoglobin in the fresh meat to the thigh, chest and back muscles was (1.91, 13.91 and 49.67) % respectively. In the fresh muscles from the femoral, thigh and back areas of the sheep were (27.89, 21.44 and 45.33) %. The percentage of oxymyoglobin in the fresh muscle (thigh, chest and back) was (23.89, 4, 50.67) %, respectively (Table 5).

While the percentage of oxymyoglobin pigment in chilled meat of thigh, chest and back muscles was 0.24, 23.34 and 51.26% respectively, and the chilled muscle of thigh, chest, and back areas of the sheep was 24.46, 18.46 and 43.02, respectively. The percent of oxymyoglobin in the chilled muscle parts of the thigh, chest and back was 19.67, 1.07 and 40.43%, respectively.

The results showed that the ratio of Oxymyoglobin in the frozen meat of the thigh, chest and back muscles was 0.72, 23.76 and 50.18%, respectively, and the frozen muscles of the thigh, chest, and back areas were 25.20, 15.17 and 44. 47% respectively. While in the frozen muscle segments of the thigh, chest and back, the oxymyoglobin was 16.67, 0.33 and 38.60%, respectively.

The highest value of Oxymyogloin of the fresh samples collected from different muscles of the beef, sheep and chicken was in the dorsal muscle of the chicken by 50.67%, while the lowest percentage of the pigment was found in the femoral muscle of the cows which was 1.91%. In the frozen samples collected from different muscles of beef, sheep and chickens had the highest percentage of Oxymyogloin pigment in the dorsal muscle of the cows which was 51.26 and 50.18%, respectively, while the percentages of the pigment were volatile in the other muscle parts of the cows, sheep and chickens, we find that the proportion of pigment was high B D hold cooling and

Table (6): Concentration of oxmyoglobin pigment in (thigh, chest and back) of fresh, chilled and frozen beef, sheep and chicken.

Type of Meat	Muscles parts	Oxymyoglobin %		
		Treatments of fresh	of Treatments chilled	Treatments of freezing
Cows	Thigh	91.1	24.0	72.0
	Chest	91.13	23.30	76.23
	Back	49. 67	26.51	18.50
Sheep	Thigh	27.89	24.46	20.25
	Chest	21.44	18.46	17.15
	Back	33.45	43.02	44.47
Chicken	Thigh	23.89	19.67	67.16
	Chest	4.00	1.07	33.0
	Back	50.67	40.43	60.38
L.S.D.$_{0.05}$ for interaction		3.98	5.98	6.03

All the results in the table are triplicate mean

freezing samples as a result of the loss of liquid. Nadh. Al-Athari (2017) showed that the concentration of Oxymyogloin pigment in minced beef was 46.74 %. A difference in the concentration of myoglobin, metamyoglobin and Oxymyogloin between the various muscle groups may be due to the difference in species or strain, as well as age differences of animals (Table 6).

Conclusions

Sheep meat showed a rise in the proportion of protein and fat compared to cows, cattle and chicken. Sheep meat was characterized by an increase in pH values and water holding capacity. Meat showed fresh cows increase in the proportion of the pigment of myoglobin and metmyoglobin compared to meat of sheep and chickens. Meat chilled and frozen chicken was characterized by a large proportion of the pigment of meth myoglobin. Fresh chicken meat contains high levels of oxmyoglobin pigment.

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