International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 1s, 2025
https://www.theaspd.com/ijes.php

Histological Study of Glycogen Concentration in Fresh and Imported Frozen Chicken Meat

Saja Kareem Najman[1] Ahmed Mahdi Al-Badri[2]
[1,2]Department of Biology, College of Science, University of Wasit, Kut, Iraq
E-mails: sajak@uowasit.edu.iq , aalmyahi @uowasit.edu.iq

Abstract: Chicken meat is an important component for its high protein and low fat characteristics. The consumption of poultry meat has increased and has reached high levels worldwide. Freezing is one of the methods of preserving meat and ensuring its quality until it reaches to the consumer. Through frozen storage, there are biochemical and physical modifications as a result of bad degree of freezing and long storage period before reaching the consumer, which can influence the frozen chicken meat quality. The aims of study are to determine the amount of glycogen content in the muscles of fresh and imported frozen chicken meat and to note the effect of the freezing and storage on the glycogen content. 30 sample of chicken muscles (leg, breast) were taken from fresh and imported frozen chicken. Collected from slaughter places and different markets of Wasit Governorate. The samples were divided into five chicken meat groups according to the type of source: fresh chicken, Iraqi frozen chicken, Iranian frozen chicken, Brazilian frozen chicken, Turkish frozen chicken. The histochemical method has been made by using Periodic acid Schiff's stain (PAS) to identify the glycogen content in the samples. The image analysis of histological results showed that the glycogen content of breast muscle in the fresh chicken was higher, followed by Iraqi, Iranian, Brazilian and lowest in Turkish chicken as recorded respectively (120.1, 116.0, 111.2, 106.4 and 98.9). likewise, leg muscles of fresh chicken showed that contain higher glycogen, followed by from Iraq, Iran, Brazil and Turkey as percentage (118.4, 114.6, 109.2, 102.2 and 94.0). Additionally, the glycogen content in skeletal muscles of the breast was showed more than in comparison with skeletal muscle of the leg.

Keywords: Glycogen, Frozen Chicken Meat, Poultry meat

1- INTRODUCTION

Poultry meat consumption and production have been increased significantly in last few years. The increased consumption and production of meat is due to the higher demands of consumers to acquire a healthy diet and meat is a necessary component of a healthy diet [1].

Glycogen is a polymer of glucose that is multibranched and have ability to store glucose when its abundant amount in body with a slight effect on osmotic pressure and used when required [2]. The glycogen quantity in the muscle tissue depends on the muscle type and animal species [3]. Muscle glycogen is an important source of glucose for muscle glycolysis [4], can supply adenosine triphosphate to muscles through its own degradation, which is closely related to muscle development and growth [5]. Muscle glycogen content affects different meat quality indicators, such as tenderness, meat color and pH of poultry meat and livestock [6]. The degradation of muscle glycogen to lactic acid changes the pH, which affects quality of meat; thus, pH is the main indicator of meat quality [7]. Naturally, the decrease in pH is considered to occur because of postmortem glycolysis with glycogen converting into lactic acid [8]. Previous studies have shown that the quantify of muscle glycogen in chickens is one of the principal factors affecting not only alteration in the eventual pH of meat at death but also its water-holding capacity, as well as other physical characteristics, including firmness and color [9]. The quantity of glycogen in skeletal muscle is roughly (1.5-1.8%) and it makes up (3-5%) of the weight of the liver. It serves as the principal source of blood sugar. One of the most important elements determining quality of final meat is the quantity of muscle glycogen present at the time of slaughter [10].

Freezing is a frequently accepted method of food conservation to ensure the meat products safety in the global meat export market [11]. The worldwide commercialization of meat calls for frozen meat which can be conserved for long periods of time with lower cost of transportation and lower price compared with fresh meat [12].

Through frozen storage, there are series of biochemical and physical modifications, such as color change, water loss, lipid and protein oxidation, which can influence the frozen chicken meat quality [13]. Several research has been done on the biochemical changes in diverse meats during frozen storage [14]. Traditional methods based on chemical and physical measurements have been done to evaluate the quality of frozen meat [15].

2. MATERIAL AND METHODS

2.1. Histochemical Study

30 sample of chicken muscles (leg, breast) were taken from fresh and imported frozen chicken. Collected from slaughter places and different markets of Wasit Governorate. The samples were divided into five chicken meat groups according to the type of source: fresh chicken, Iraqi frozen chicken, Iranian frozen chicken, Brazilian frozen chicken and Turkish frozen chicken. Periodic Acid Schiff Stain (PAS) is utilized for the identification of the glycogen in the tissues [16].

2.2. Statistical Analysis

The canon digital camera mounted on a Mejia microscope with a 1/2 X photo converter was utilized to take photos of a histological investigation. The photographs were analyzed using image analysis software called Picture Test Morphology (Image J), which has a specific built-in function for measuring area, percent area and counting objects.

3. RESULTS AND DISCUSSION

The histochemical results of the skeletal muscles of the breast and leg regions and livers were applied to estimate the glycogen distribution after the sections stained with periodic acid Schiff (PAS) reagents.

The microscopic examination of cross sections of skeletal muscle of fresh chicken meat showed the accumulation of large amount of glycogen deposits inside breast and leg muscles, which appeared in a dark purple color. The percentage of glycogen is estimated (120.1±1.05 , in breast), (118.4±1.80, in leg) as shown in (Figures 1, 2). This result agreed with study of [17] when they found skeletal muscle of fresh local meat appeared with excessive amounts of glycogen content in the muscle cells.

In Iraqi frozen chicken meat, the results of the histological sections of the breast and leg presented that the distribution of glycogen content in the tissues was less than the glycogen content in fresh meat, these statistically calculated (116.0±5.34, breast) (114.6±5.36, leg) which represent as displayed (Figure 3, 4).

In Iranian frozen chicken meat, the histological sections of the breast and leg showed moderate glycogen content which marked in purple color. This amount of glycogen has been valued (111.2±1.06, breast) (109.2±4.47, leg) as observed in (Figure 5, 6). This result agreed with study of [18] when they found decreased glycogen content in frozen chicken meat.

In Brazilian frozen chicken meat, the results of glycogen scattered in muscles of breast and leg showed that little glycogen content in the sections, as estimated (106.4±7.07, breast)(102.2±0.93, leg) (Figure 7, 8).

In the muscles breast and leg of Turkish frozen meat which stained with the PAS techniques showed very little glycogen content compared to previous products which stained in purple color. This amount of glycogen has been valued (98.9±10.23, breast)(94.0±5.82, leg) as observed in (Figures 9, 10).

By comparing the above results, it was found that in the breast and leg the glycogen content differed significantly (p≤0.05) between the species , as illustrated in (Table 1), (Table 2). Additionally, it was found that the glycogen content in fresh breast and leg was higher compared to the frozen, as shown in (Chart 1), (Chart 2) .

(Table 1): Mean values and standard deviation of the glycogen contents of the fresh and frozen chicken breast meat.

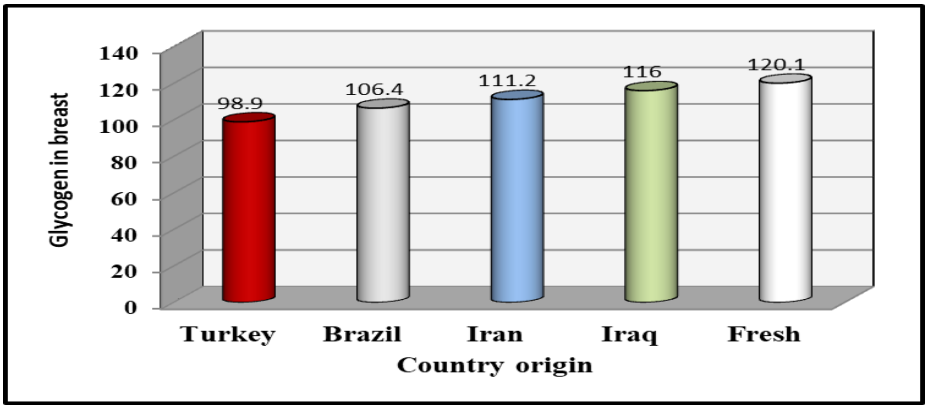
Country origin	Mean ± SD				P-Value
Turkey	98.9	±	10.23	c©	0.013*
Brazil	106.4	±	7.07	bc	
Iran	111.2	±	1.06	ab	
Iraq	116.0	±	5.34	ab	
Fresh	120.1	±	1.05	a	
LSD 0.05	11.08				

Data presented as Mean ± SD ©Means followed by different letters are significant different at P≤ 0.05 **: Significant at (P≤ 0.01)

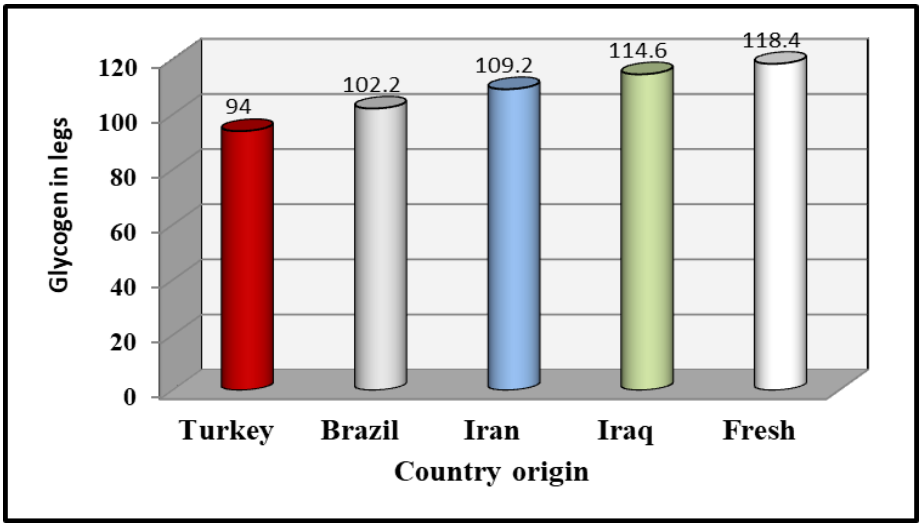
(Table 2): Mean values and standard deviation of the glycogen contents of the fresh and frozen chicken leg meat.

Country origin	Mean ± SD				P-Value
Turkey	94.0	±	5.82	d©	0.001**
Brazil	102.2	±	0.93	c	
Iran	109.2	±	4.47	bc	
Iraq	114.6	±	5.36	ab	
Fresh	118.4	±	1.80	a	
LSD 0.05	7.57				

Data presented as Mean ± SD ©Means followed by different letters are significant different at P≤ 0.05 **: Significant at (P≤ 0.01)



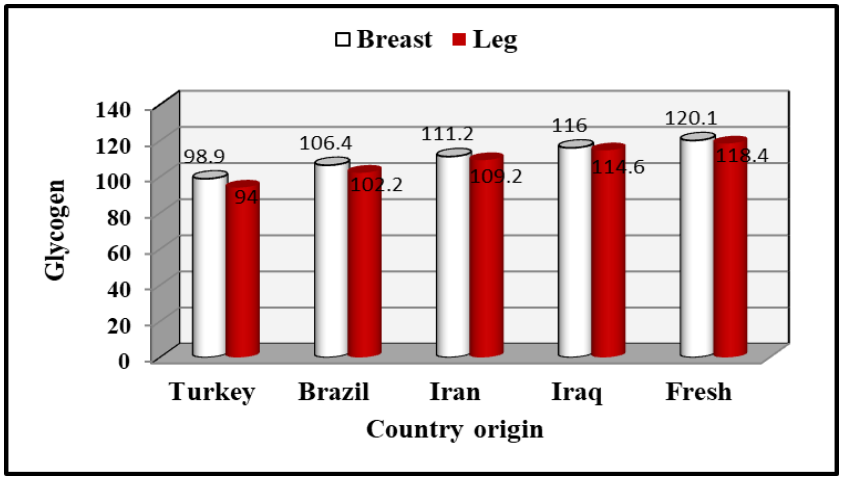
(Chart 1): The ratio of glycogen contents of breast skeletal muscle at different products.



(Chart 2): The ratio of glycogen contents of leg skeletal muscle at different products.

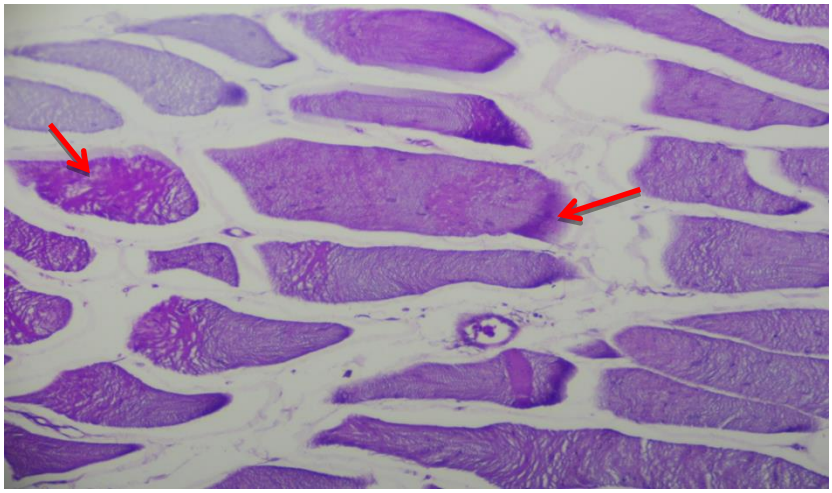
In this study, the glycogen content of frozen chicken meat showed decreased may be due to increase storage period of meat. [19] found that during cold storage of muscle, glycogen is different into lactic acid due to presences of amylolytic enzymes are responsible which cause gradual decline in glycogen content. [20] also found that in the anaerobic conditions glycogen of muscle also breakdown into lactic acid which cause decrease of muscle glycogen content during storage.

The results of current study were appeared the different content of glycogen between the breast and the leg in the study. The glycogen content in skeletal muscles of the breast was more than in comparison with skeletal muscle of the leg (chart 3). These results agreed with [21] then they showed that the glycogen content of chicken breast muscle was greater than that of leg muscle.

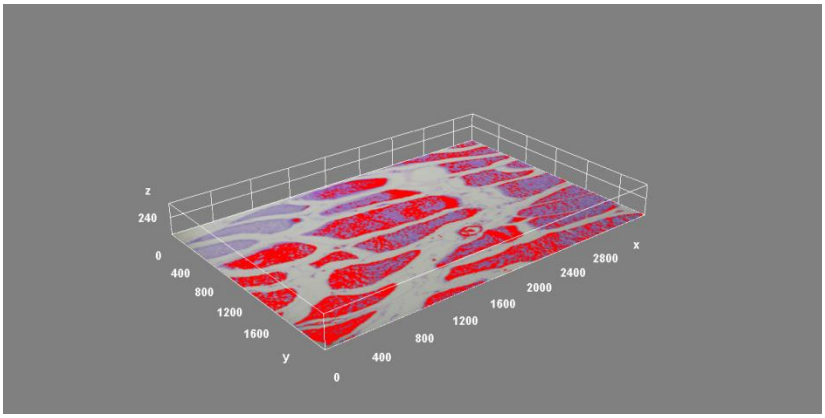


(Chart 3): The ratio of glycogen contents of leg and breast skeletal muscle at different products.

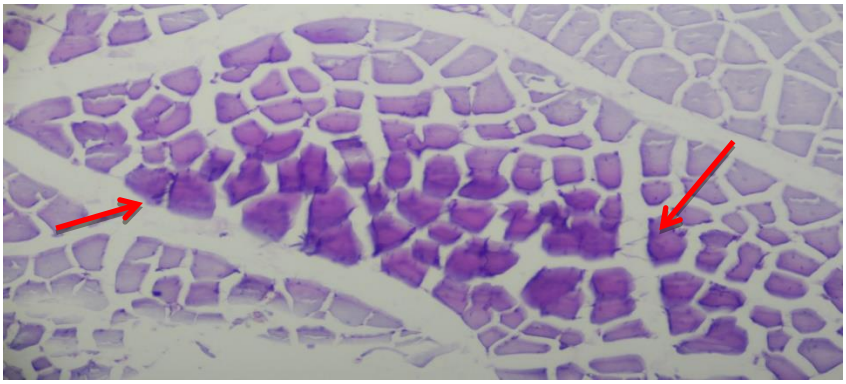
The alterations in glycogen contents in muscle through fibers types and location of muscle may be due to the metabolic process which take place in muscles to prove the movement functions and energy supply. Some authors explained this difference [22], glycolytic fibers contain more glycogen than oxidative fibers. Through microscopic study of the chicken's muscles, it was showed that the breast muscles are made up of white glycolytic fibers, which depend on the breakdown of sugar to provide energy different the leg muscles, which are made up of red and white fibers, and this description was similar to that of [23], who explained the type of fibers that make up chickens muscles.



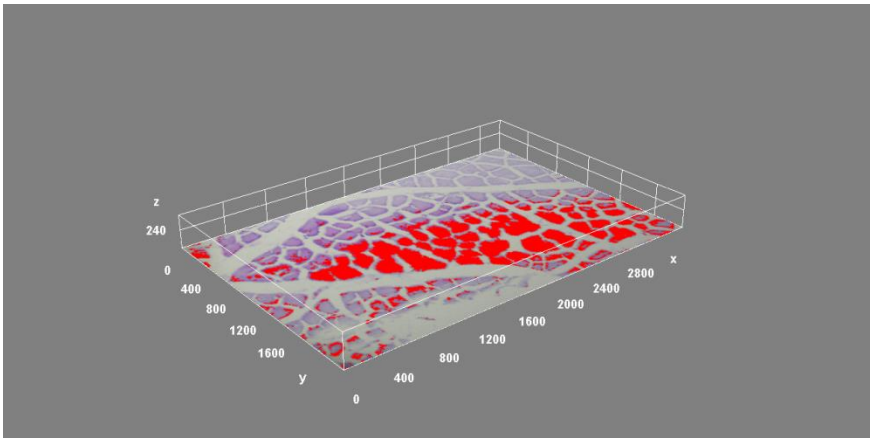
(Figure 1) A: Photomicrograph of cross section of breast skeletal muscles of fresh chicken meat show large diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



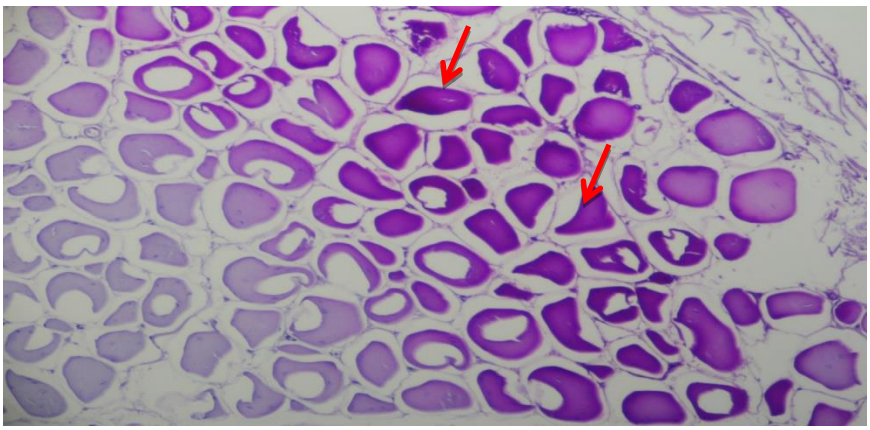
(Figure 1) B: Surface plot show cross section of breast skeletal muscles of fresh chicken meat by using (image J).



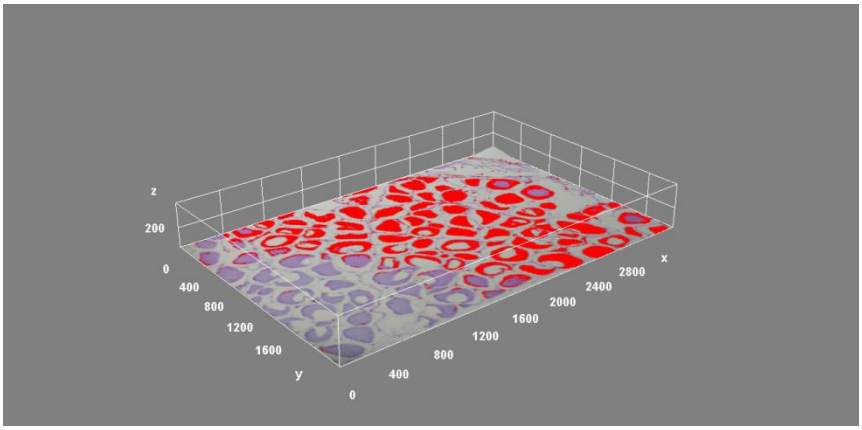
(Figure 2) A: Photomicrograph of cross section of leg skeletal muscles of fresh chicken meat show large diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



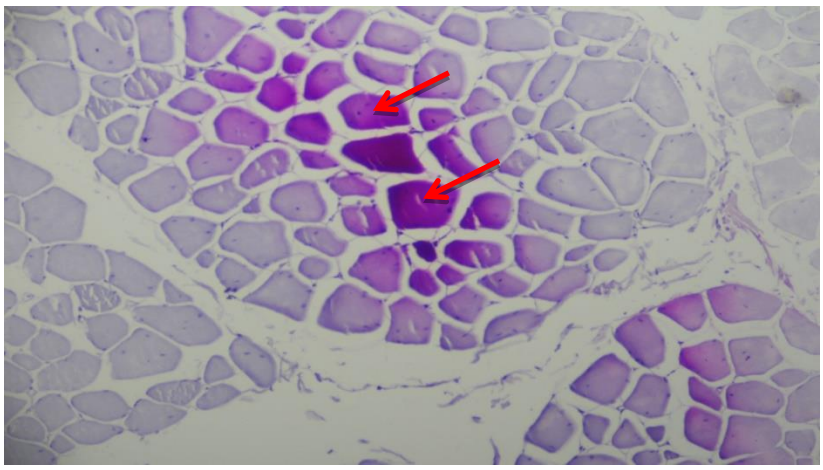
(Figure 2) B: Surface plot show cross section of leg skeletal muscles of fresh chicken meat by using (image J).



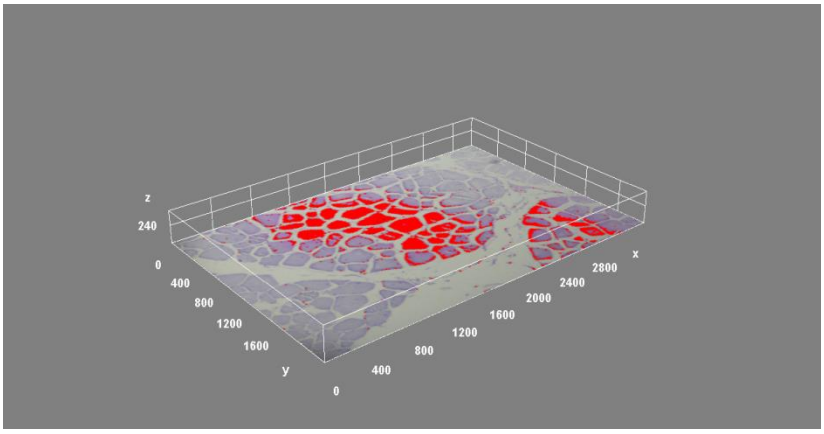
(Figure 3) A: Photomicrograph of cross section of breast skeletal muscles of Iraqi frozen chicken meat show the diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



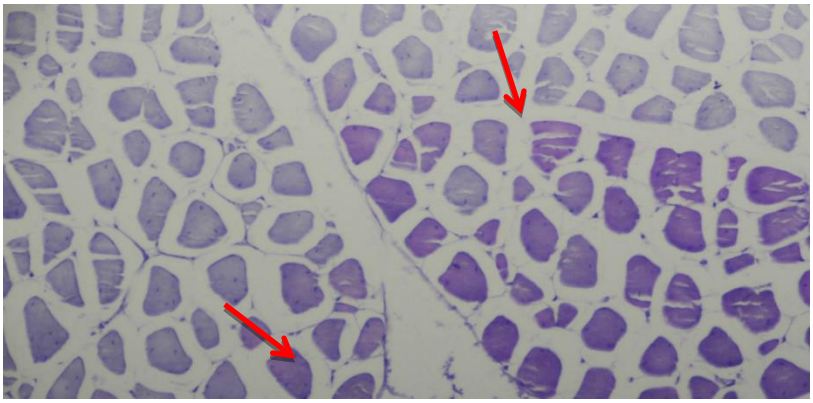
(Figure 3) B: Surface plot show cross section of breast skeletal muscles of Iraqi frozen chicken meat by using (image J).



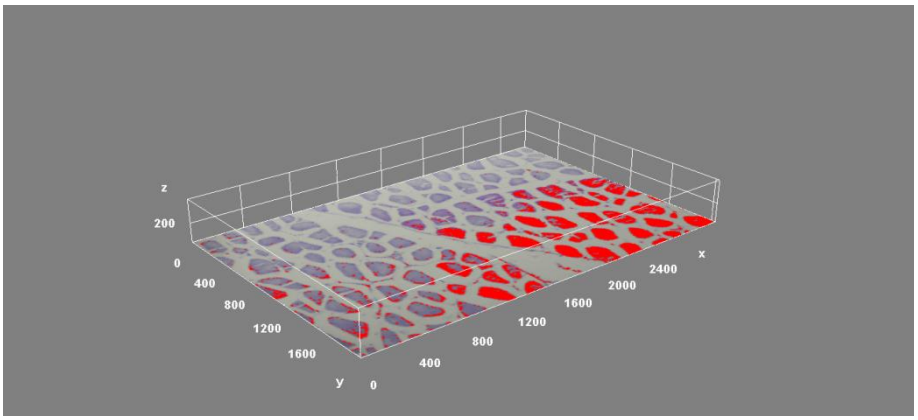
(Figure 4) A: Photomicrograph of cross section of leg skeletal muscles of Iraqi frozen chicken meat show the diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



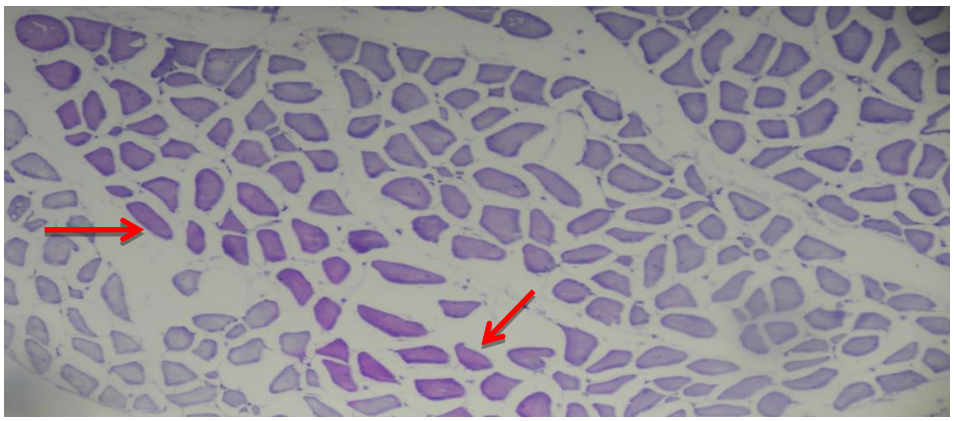
(Figure 4) B: Surface plot show cross section of leg skeletal muscles of Iraqi frozen chicken meat by using (image J).



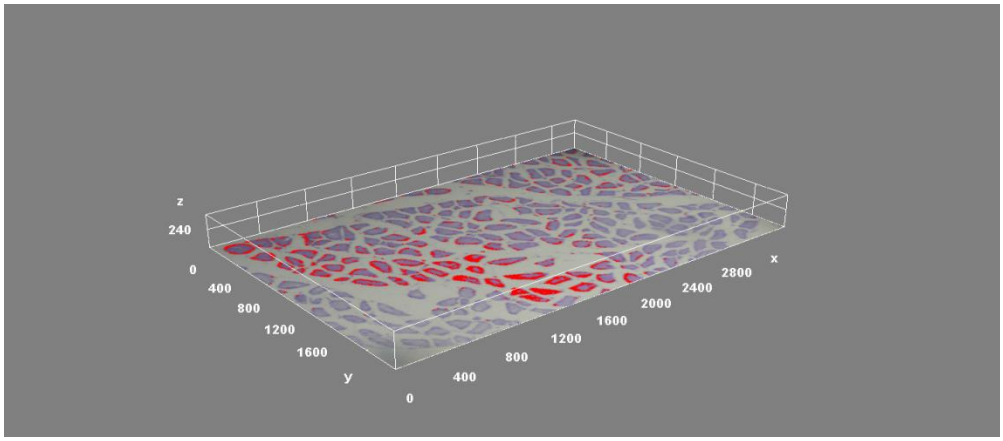
(Figure 5) A: Photomicrograph of cross section of breast skeletal muscles of Iranian frozen chicken meat show moderate diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



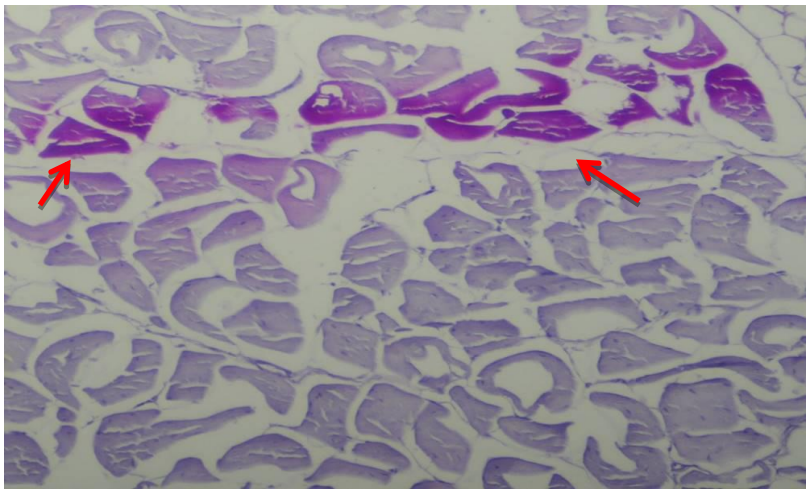
(Figure 5) B: Surface plot show cross section of breast skeletal muscles of Iranian frozen chicken meat by using (image J).



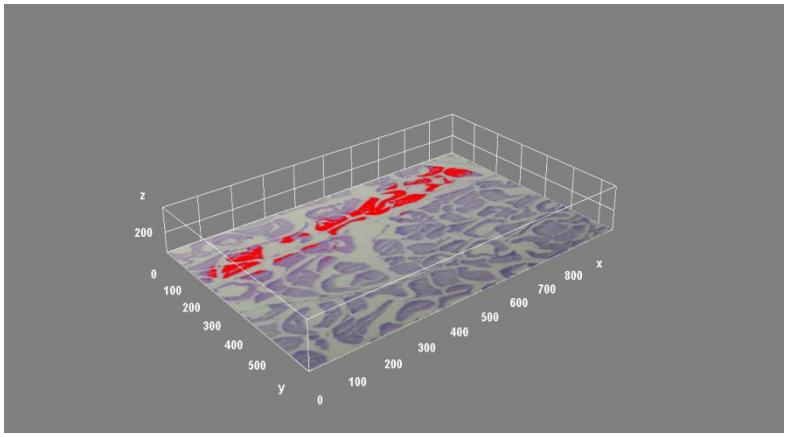
(Figure 6) A: Photomicrograph of cross section of leg skeletal muscles of Iranian frozen chicken meat show moderate diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



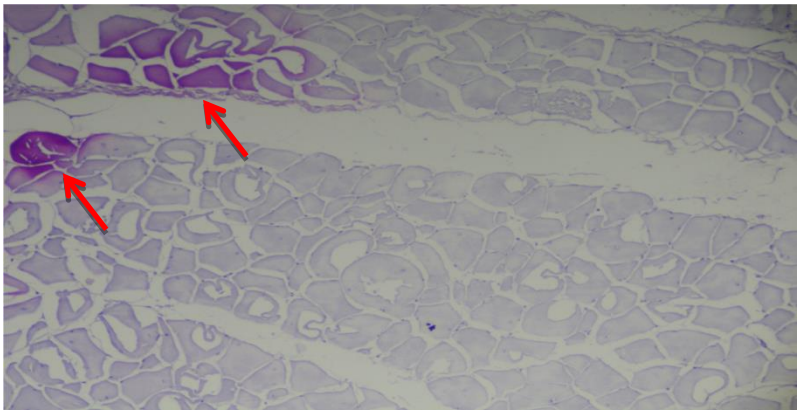
(Figure 6) B: Surface plot show cross section of leg skeletal muscles of Iranian frozen chicken meat by using (image J).



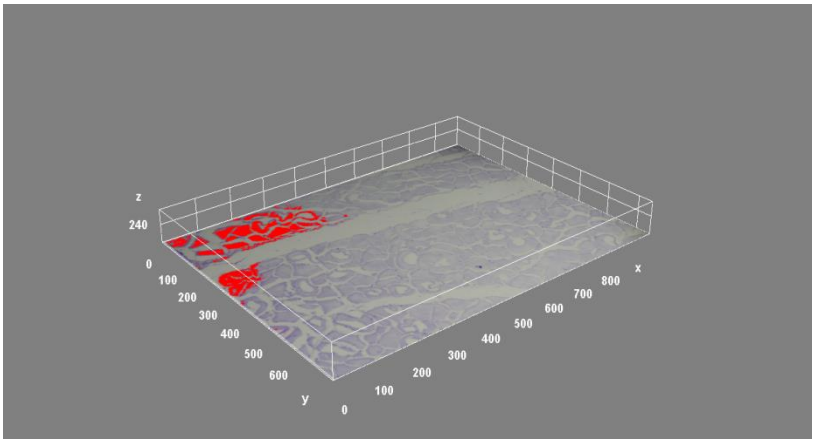
(Figure 7) A: Photomicrograph of cross section of breast skeletal muscles of Brazilian frozen chicken meat show little diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



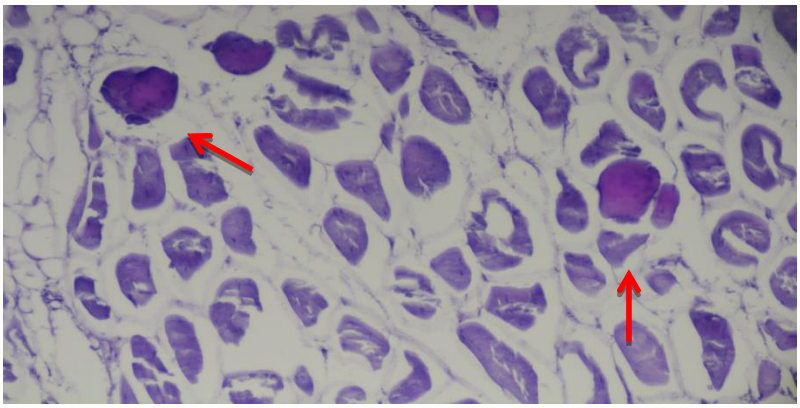
(Figure 7) B: Surface plot show cross section of breast skeletal muscles of Brazilian frozen chicken meat by using (image J).



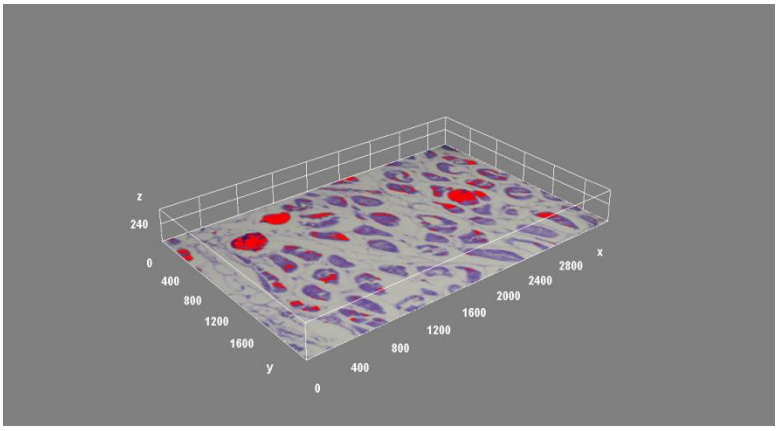
(Figure 8) A: Photomicrograph of cross section of leg skeletal muscles of Brazilian frozen chicken meat show little diffusion of glycogen (red arrow) within the muscle. PAS stain (200X).



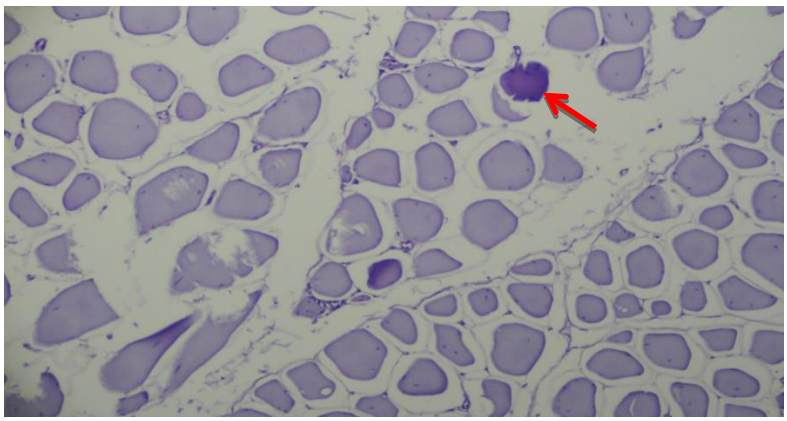
(Figure 8) B: Surface plot show cross section of leg skeletal muscles of Brazilian frozen chicken meat by using (image J).



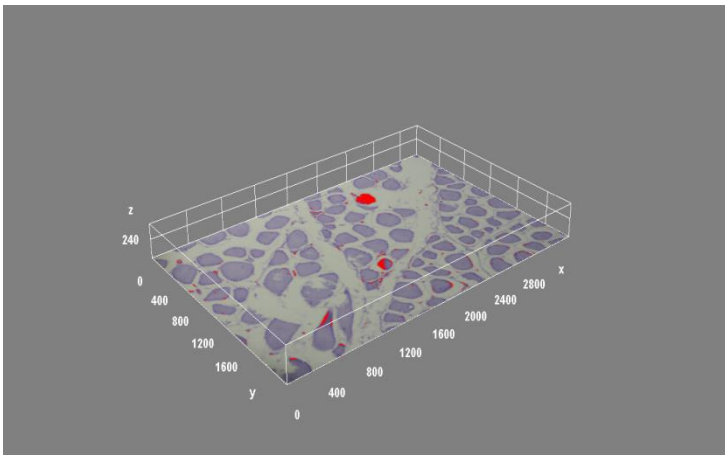
(Figure 9) A: Photomicrograph of cross section of breast skeletal muscles of Turkish frozen chicken meat show very little content of glycogen (red arrow) within the muscle. PAS stain (200X).



(Figure 9) B: Surface plot show cross section of breast skeletal muscles of Turkish frozen chicken meat by using (image J).



(Figure 10) A: Photomicrograph of cross section of leg skeletal muscles of Turkish frozen chicken meat show very little content of glycogen (red arrow) within the muscle. PAS stain (200X).



(Figure 10) B: Surface plot show cross section of leg skeletal muscles of Turkish frozen chicken meat by using (image J).

CONCLUSION

The glycogen content in skeletal muscles of the breast was more than in comparison with skeletal muscle of the leg . Additionally, the glycogen content of breast and leg muscles in the fresh chicken was higher, followed by Iraqi, Iranian, Brazilian and lowest in Turkish chickens. The frozen products differ in their glycogen content that probably result from being fed before slaughter or storage period and the degree and duration of the freezing before reaching the consumer.

REFERENCES

1. Marangoni F, G. Corsello, C. Cricelli, N. Ferrara, A. Ghiselli, L. Lucchin and A. Poli (2015). Role of poultry meat in a balanced diet aimed at maintaining health and wellbeing: an Italian consensus document. Food Nutr. Res. (59): 27606.
2. Roach, P. J., A. A. Depaoli-Roach, T. D. Hurley, and V. S. Tagliabracci. 2012. Glycogen and its metabolism: some new developments and old themes. Biochem. J. 441:763-787.
3. Monin, G., Przybylski, W. and Kocwin-Podsiadla, M. (2003). Glycolytic potential as meat quality determinant. Proc. The IV Conference on effect of genetic and non-genetic factors on carcass and meat quality of pigs.
4. Godfrey, R., and Quinlivan, R. (2016). Skeletal muscle disorders of glycogenolysis and glycolysis. Nat. Rev. Neurol. 12, 393–402.
5. Puolanne, E., & Immonen, K. (2014). Conversion of Muscle to Meat.Glycogen. Encyclopedia of Meat Sciences, 346–352.
6. Le Bihan-Duval, E., Debut, M., Berri, C. M., Sellier, N., Santé-Lhoutellier, V., Jégo,Y., et al. (2008). Chicken meat quality: genetic variability and relationship withgrowth and muscle characteristics. BMC Genet. 9:53.
7. Alnahhas, N., Le Bihan-Duval, E., Baéza, E., Chabault, M., Chartrin, P.,Bordeau, T. (2015). Impact of divergent selection for ultimatepH of pectoralis major muscle on biochemical, histological, and sensorialattributes of broiler meat. J. Anim. Sci. 93, 4524–4531.
8. Scheffler, T. L., Park, S. and Gerrard, D. E. (2011). Lessons to learn about postmortem metabolism using the AMPKγ3 R200Q mutation in the pig. Meat Sci. 89:244-250.
9. Berri, C., Besnard, J. and Relandeau. C. (2008). Increasing dietary lysine increases final pH and decreases drip loss of broiler breast meat. Poult. Sci. 87:480-484.
10. Melendez R., Melendez-Hevia E., Canela E. I. (1999). The fractal structure of glycogen: a clever solution to optimize cell metabolism. Brophy's. J. 77: 1327-1332.
11. Leygonie C, Britz TJ, Hoffman LC. (2012). Impact of freezing and thawing on the quality of meat: Review. Meat Sci;91:93-8.
12. Pietrasik Z , Janz J. (2009). Influence of freezing and thawing on the hydration characteristics, quality, and consumer acceptance of whole muscle beef injected with solutions of salt and phosphate. Meat Sci;81:523-32.
13. Soyer A, Ozalp B, Dalmış U, Bilgin V. (2010). Effects of freezing temperature and duration of frozen storage on lipid and protein oxidation in chicken meat. Food Chem;120:1025-30.
14. Muela E, Sanudo C, Campo MM, Medel I, Beltrán JA. (2010). Effect of freezing method and frozen storage duration on instrumental quality of lamb throughout display. Meat Sci;84:662-9.
15. Damez JL, Clerjon S. (2008). Meat quality assessment using biophysical methods related to meat structure. Meat Sci;80:132-49.
16. Suvarna, K. S.; Layton, C. & Bancroft, J. D. (2018). Bancroft's theory and practice of histological techniques E-Book. Elsevier Health Sciences.
17. Al Salman, A. A J. & Al-badri, A. (2023). Distribution of Glycogen Content in Beef Meat from Different Products. IOP Conference Series: Earth and Environmental Science, 1262:1-7.

18. Tarique, A. K., Atta H. S., Muneer A. J. and Asghar A.K (2022). Effect of Low Temperature Preservation and Post-Thawing on Chemical Attributes of Buffen, Chevon and Chicken Meat. Pakistan Journal of Zoology, 55(3):1-8.
19. Dave, D., and Ghaly, A.E., (2011). Meat spoilage mechanisms and preservation techniques: A critical review. Am. J. Agric. biol. Sci., 6: 486-510.
20. Rahman, M.H., Hossain, M.M., Rahman, S.M.E., Amin, M.R., and Oh, D.H., (2015). Evaluation of physicochemical deterioration and lipid oxidation of beef muscle affected by freeze-thaw cycles. Korean J. Fd. Sci. Anim. Resour., 35: 772-782.
21. Yu, L. H., Lee, E. S., Chen, H. S., Jeong, J. Y., Choi, Y. S., Lim, D. G., & Kim, C. J. (2011). Comparison of physic°Chemical characteristics of hot-boned chicken breast and leg muscles during storage at 20°C. Korean Journal for Food Science of Animal Resources, 31(5), 676-683.
22. Henckel, P., A. Karlsson, M. T. Jensen, N. Oksbjerg, and J. S Petersen (2002). Metabolic conditions in Porcine longissimus muscle immediately pre-slaughter and its influence on peri- and post mortem energy metabolism. Meat Sci. 62:145–155.
23. Weng, K., Huo, W., Li, Y., Zhang, Y., Zhang, Y., Chen, G., & Xu, Q. (2022). Fiber characteristics and meat quality of different muscular tissues from slow-and fast-growing broilers. Poultry Science, 101(1), 101537.