# INVESTIGATION OF DIFFERENT THAWING METHODS COMBINED WITH FREEZING RATE ON SLAB SHAPE MEAT QUALITY

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**Abstract –The effect of two freezing processes having different freezing rates combined with slow thawing, ambient thawing and quick thawing on the slab shape raw meat quality is investigated. Drip loss, heme iron and protein analysis combined with hardness measurements are evaluated as quality indicators for frozen-thawed meats compared to fresh meat. Compared to fresh meat, drip losses of 0,4%, 3,0%, 4,6% are found for quick frozen and thawed (QF-QT), slow frozen and thawed (SF-ST), slow frozen and on-counter thawed (SF-OCT) respectively. QF-QT meat samples preserves the %81 of the heme iron content of the fresh meat, while SF-RT and SF-OCT preserves %58 and 44% respectively. Similar positive effect has also been observed in the hardness value of the raw meat for QF-QT.**

**Key Words – Heme iron, Quick freezing-thawing, Raw meat**

Abbreviations

ft: frozen-thawed
frh: fresh
m: meat
W: weight (g)
DL%: Drip loss (%)
QF: Quick frozen
QT: Quick thawed
SF: Slow frozen
ST: Slow thawed
OCT: On counter thawed
FM: Fresh meat

## I. INTRODUCTION

Although there have been intensive work on food quality and safety in the past years, they are mainly focused on food production and storage. However, it has been observed that this trend is about to change as more studies are being done on food freezing, cooling and thawing and their combined processes. Freezing and thawing mainly influence the water fraction of meat. Therefore, the majority of the research conducted on freezing and thawing of meat has focused on the reduction of moisture or drip loss [1].

The formation of ice crystals during freezing damages the ultrastructure and concentrates the solutes in the meat which, in turn, leads to alterations in the biochemical reactions that occur at the cellular level and influence the physical quality parameters of the meat. Therefore, tenderness (shear force) is measured in most of the studies on raw meat freeze-thaw processes [1].

Freezing rate is an important parameter in the preservation of meat quality during the freezing process. Ramaswamy and Marcotte [2] mentioned that freezing rate can be taken as the ratio of slab thickness to the freezing time of the meat. In their definition, half-thickness is taken for double-side freezing and full thickness is taken for single-side freezing. Also, it should be noted that the freezing time is calculated as the time for the center temperature to pass between -1°C and -5°C region as the most of the phase change occurs in this range.

Thawing is also a quite important process following the freezing in terms of meat quality. There are various ways of thawing meat such as slow thawing, ambient temperature (counter-top) thawing, water immersion thawing, lotic water thawing and microwave thawing as studied by Xia et al. [3]. Despite the fact that the counter-top or ambient thawing increases the drip loss and is not suggested by the food codes and regulations [4, 5] due to the risk of microbial spoilage, almost %50 of consumers are still favoring this thawing method due to simplicity [6, 7, 8]. The increased drip loss of muscle can lead to less acceptability, due to the loss of tasteful constituents, such as some amino acids or nucleotides. Also, nutritional constituents such as heme iron and heme pigment must be preserved by these processes as these pigments are mostly found in beef.

In this study, the effect of two freezing processes having different freezing rates combined with slow thawing, ambient thawing and quick thawing on the slab shape raw meat quality is investigated. Drip loss, heme iron and protein analysis combined with hardness measurements are evaluated as quality indicators for frozen-thawed meats compared to fresh meat.

## II. MATERIALS AND METHODS

### 2.1. Preparation of Meat Samples

*Longissimus dorsi* muscle was selected as freezing and thawing operations. Samples were received from a local butcher and immediately bring to laboratory for trimming in a rectangular slab shape. Then, shaped meat samples were packaged by wrapping with LDPE strech film (Korozo Koroplast, Turkey). After packaging, samples were frozen- thawed with different conditions and compared with control (fresh meat; unfrozen-unthawed) samples.

Fresh meat samples were frozen at two different freezing rate range: 1) Quick freezing: 1.5-2.5 cm/h) Slow freezing: 0.2-0.6 cm/h

Samples were frozen to a meat central temperature of -18C, and stored at -18C for 24 h.

For each freezing process, three different thawing processes; slow thawing (<0,1cm/h) ambient (on-counter) thawing (25°C) and quick thawing (>1,0cm/h) were applied to meat samples.

### 2.2. Drip Loss Analysis

Drip loss of the frozen-thawed slab shape red meats was determined from the known weights of meat before and after freeze-thaw processes.

$$DL\% = \frac{W_{ft,m} - W_{frh,m}}{W_{frh,m}} * 100$$

### 2.3. Heme Pigment Analysis

The concentration of total heme pigment and heme iron of fresh and frozen-thawed meats was anaylsed according to Hornsey Method (Escudero et al., 2010). Analysis was performed for both of meat and drip samples. Samples were diluted with water, acetone and concentrated HCl and then homogenized with blender. Homogenized samples were taken to the tubes with capped and allowed to stand in a dark places for 1 hour, then centrifuged. The supernatant was filtered with GF/A or Sartorious 532 filter. Absorbance of filtered solution was measured at 640 nm. the heme pigment (hematin) content was obtained by multiplying the absorbance by the factor 680, expressed as ppm (Hornsey, 1956). The heme iron content was calculated by multiplying with the factor of 0.0882 µg iron/µg hematin (Merck, 1989)

### 2.4. Protein Content Analysis

Protein content of meat samples was determined according to FOSS Application Note on protein analysis of meat and meat products. FOSS Kjeltec 8100 Distillation Unit was used. First, grinded samples are digested under $H_2SO_4$ and potassium sulphate, nitrogen is turned to ammonium sulphate. Excess sodium hydroxide is added and free ammonium is released. Released ammonium is kept with weak boric acid, then titrated with standardized HCl.

### 2.5. Hardness Analysis

Hardness of fresh and frozen-thawed samples was determined by cutting with V-shaped Warner Bratzler shear blade attached to a texture analyser (Texture Analyzer Model TA Plus, Lloyd Instruments Ltd., Hampshire, England) and expresses as Newton (N). Load cell capacity is 0.5 kN, Cutting speed is 50 mm/min. and trigger force is 0.05 N.

Prior to analyses, meat samples were cooked to an inner temperature of 72°C with a conventional turbo oven. After cooking, the samples were cooled to room temperature and stand for 24 h at 4°C. Then, samples were cut with a dimension of 1cm*1cm*2cm (W*H*L) parallel to muscle fibers.

### III. RESULTS AND DISCUSSION

Ice formation in intracellular and extracellular space of myofibriller fibres during freezing and thawing processes can cause drip loss osmotically, protein denaturation and mechanical damages. protein found in drip is mainly water-soluble proteins. Water and water soluble proteins, amino acids and nucleotids excreted outside from cell inside by damages to cellular structure [9].

Meat has a heme iron content as 26.2-75.60% of its iron content. Red meat has higher heme iron content than poultry meat, because of heme iron found in myoglobin and hemoglobin molecules. Heme iron has two to three times higher bioavailability than non-heme iron [10]. Therefore, heme iron is shown as very important micronutrient by surviving with iron deficiency. Heme iron is water-soluble and can loss with drip during thawing.

Table 1 shows the effect of freezing-thawing processes on the drip loss, total heme pigment content, total heme iron content and hardness of longissimus muscle.

Table 1 Influence of thawing methods on the drip loss, total heme pigment content, total heme iron content and hardness of longissimus muscle

| Condition * | Drip Loss (%) | Total Heme Pigment Content (mgHematin/ 100g meat) | Heme Iron Content (mgHeme Iron /100g meat) | Hardness (N) |
|---|---|---|---|---|
| FM | - | 63,12 | 5,57 | 26,17 (±5,92) |
| QF-QT | 0,4 | 51,11 | 4,51 | 23,44 (±3,16) |
| SF-ST | 3,0 | 36,60 | 3,23 | 34,35 (±5,84) |
| SF-OCT | 4,6 | 27,75 | 2,45 | 37,85 (±6,61) |

* **FM**, Fresh meat; **QF-QT**, Quick Frozen and Thawed; **SF-ST**, Slow Frozen and Thawed; **SF-OCT**, Slow Frozen and On-counter Thawed

Among the other freezing and thawing processes, it has been found that Quick frozen and quick thawed meat samples has negligible (%0,4) drip loss while preserving heme pigment and heme iron content compared to fresh meat (Table 1).

Figures 1 and 2 shows the images of different frozen-thawed meats. It is well observed that both the meat appearance and drip loss degredation is favorable for quick frozen and quick thawed meat samples.

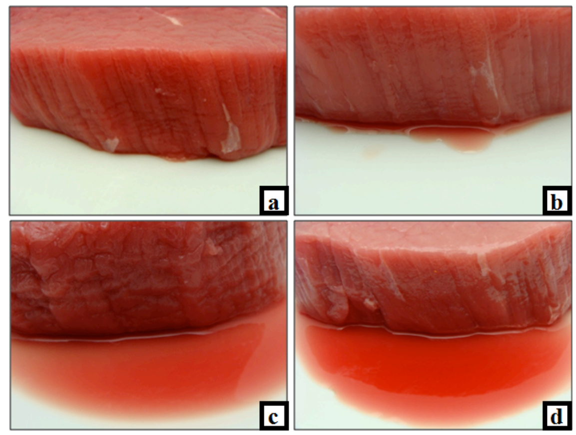


Figure 1. Images of different frozen-thawed meats: a- Fresh meat, b-Quick frozen-quick thawed meat c- Slow frozen and thawed meat d- Slow frozen and on-counter thawed meat

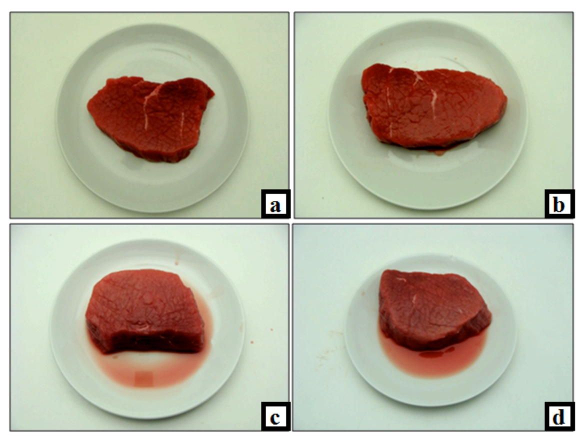


Figure 2. Overview of different frozen-thawed meats: a- Fresh meat, b-Quick frozen-quick thawed meat c- Slow frozen and thawed meat d- Slow frozen and on-counter thawed meat

Protein content of meat samples are given in Figure 3. Quick frozen and quick thawed (QF-QT) meat samples preserve their protein content while the SF-ST and SF-OCT meat samples loses considerable amount of their possible water soluble protein content into the drip.

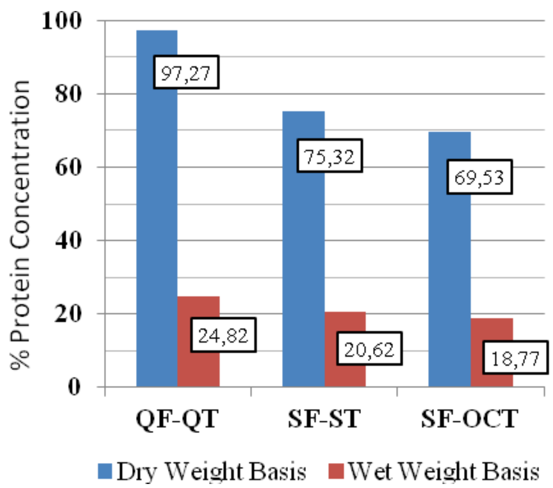


Figure 3. Protein concentration of different processed meats

## IV. CONCLUSION

Quick frozen and quick thawed meat samples has negligible (%0,4) drip loss while preserving heme pigment and heme iron content compared to fresh meat among the other freezing and thawing processes. This shows that, combined quick freezing and quick thawing provides the minimum microcellular damage to the raw meat compared with others.

The images of different frozen-thawed meats also showed that both the meat appearance and drip loss degredation is favorable for quick frozen and quick thawed meat samples.

Protein content analysis showed that quick frozen and quick thawed (QF-QT) meat samples preserve their protein content while the SF-ST and SF-OCT meat samples loses considerable amount of their possible water soluble protein content into the drip.

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