Frozen Meat Technology

Presented by DR. HAROLD J. TUMA

The study concerns itself with frozen meat color, appearance, and color retention. Processing and raw product technology are analyzed as to how they affect frozen meat color

Dr. HAROLD J. TUMA is an Associate Professor, Meat Science, Kansas State University. He is research coordinator for various meat systems research projects involving product development, packaging, marketing production and cost anaylsis. President-elect of the Kansas City Section of the Institute of Food Technologists. Director of American Meat Science Association. Member and/or chairman of ten regional or national food industry advisory or planning committees.

Interest in frozen meat has arisen frequently in the past and many things being said today about its potential advent sound like a replay of speeches 15-20 years ago. There are some developments and changes that have occurred the past 4-5 years that I will incorporate into the topic of "Frozen Meat Technology".

The objective of any preservation system is to maintain the product as close to its natural state as possible with regard to *color, palatability, nutritive content, freshness* and *wholesomeness.*

In some previous work (Smith, 1970, Urbain, 1971), it was concluded that there was essentially no change in palatability, nutritive content, freshness and wholesomeness when product was held for a reasonable length of time (approximately 6-8 months).

Table 1 illustrates some beef taste panel and shear tenderness data by Smith, 1970. The taste panel and shear data both indicated no significant difference among the fresh, frozen and frozen-stored steaks. Additional data, also from this study, indicated a *35-80% decrease* in surface microorganisms associated with a cryogenic freezing system.

If the assumption is correct, that palatability, nutritive content, frenshness and wholesomeness do not change, then the main research concern is color or appearance.

The objective of this series of studies has been to improve frozen meat color, appearance and color retention or shelf life. In the past, frozen meat has been dark in color and had ice crystals between the product and packaging materials.

To simplify the discussion, frozen meat color is divided into two categories:

I. Processing Technology
   - Fabrication conditions
   - Packaging
   - Freezing
   - Storage
   - Retail case

II. Raw Product Technology
   - Beef, lamb & pork
   - Muscle variation
   - Within muscle variation
   - O_2 demand
   - Basic muscle characteristics

This is done because of the vast raw product variation. Some meat properly frozen never would look good and by the same token, a good raw product can be abused at some point in processing to give an unattractive product.

An evaluation of Raw Product Technology:

1. It is well-known that beef has the most pigment and that pork has the least with lamb in between (Briskey & Kauffman, 1971). Also there appears to be a close relationship between the total amount of pigment (Myoglobin and Hemoglobin) and the freezing and processing problems to overcome and yet end up with an attractive product. The packaging, freezing and other marketing variables are not as critical with pork to end up with an attractive frozen product.
2. It is also well-known that there are variations in the total pigment content among the different muscles in the carcass, for example, the rib eye has less pigment than the tenderloin.
3. Individual muscles vary widely in pigment content as shown in Table 2. These light and dark muscles were from animals of the same physiological age yet the pigment in the *Spinalis dorsi* muscle varied up to 60% in total pigment content. This was not expected.
4. It is known that beef varies in bloom time but the basic reasons why are not known and little is known

Table 1. Fresh vs Frozen Beef Steak Tenderness[1]

	Taste T.[2]	Shear[3]
Fresh	5.44	2.79
Frozen	5.46	2.91
Frozen Stored	6.06	2.90

[1]The higher the value the more tender.
[2]Taste Panel Evaluation
[3]Warner-Bratzler Shear Evaluation

Table 2. Frozen Color and Muscle Pigment

Muscle Color		Visual Color Score[1]	TP[2]
Light	LD[3]	2.0	3.81
	SD[4]	2.5	4.75
Dark	LD	2.88	4.53
	SD	4.88	7.51

[1] 1 = Bright cherry red
5 = Dark red
[2] TP = Total pigment exposed as miligrams per gram of wet tissue
[3] LD = Longissimus Dorsi
[4] SD = Spinalis Dorsi

about the variation in oxygen demand for these various muscles yet this is important to many of the processing variables.

An evaluation of the Processing Technology:

1. Fabrication conditions. Bloom time may vary between 10-30 minutes for satisfactory frozen meat color. Cutting room temperature – the lower or closer to 30° F the better but obviously worker comfort has to be considered. Product has been processed between 50 and 60°F satisfactorily.
2. Packaging. Packaging has to be the major area of advancement in the past five years. In the past, frozen meat has been processed in a cardboard carton or in a film in which the color was bad or there was a large amount of ice crystal formation. The new skin-tight Bivac packaing process developed by DuPont has proven that packaging can be accomplished with no frost accumulation yet enough oxygen permeability in the film to hold a very acceptable frozen meat color. This system uses an iolon ionomer film.
3. Freezing. As is already known, slow freezing produces a dark color in frozen meat and rapid freezing tends to set the bloom and allow for a nice bright red color. It is possible to freeze a product too fast and this can give a bleached affect. The various systems that appear satisfactory and can be used for cryogenic freezing are liquid nitrogen, carbon dioxide, liquid air and freon.
4. Storage. Storage is not any particular problem when the product is properly frozen and packaged with no light reaching the product. Studies have been conducted at Kansas State to indicate that packaging at storage temperatures of −10° with no light will produce an acceptable product after a six month period of time.
5. Retail case. There are a number of areas to be considered when evaluating the type of retail case for frozen product.

Temperature: It should be emphasized that the retail case air temperature is completely different from product temperature. Normally, the product temperature will be 10-15 degrees higher than the ambient air temperature. Research studies indicate that an ambient air temperature of −20° or lower is normally satisfactory to hold an acceptable shelf life period and color.

Light consideration: There are several different sources that are acceptable that will be discussed by Kropf *et al.* in a parallel paper. A major problem is too many foot candles of light in many meat cases which causes a degeneration of the oxymyoglobin. The limit here is roughly 100 foot candles.

Defrost cycles: The cycles of the retail case should be limited to as few as possible and they should occur at sometime when the store is closed. Frost accumulation may occur on the outside of the frozen packages during the defrost cycles and it takes one to two hours to dissipate.

Overloading: It is also a very common occurrence to overload cases or load them above the "load limit" level. This will cause the temperature in the packages to rise and, hence, discoloration to occur.

Summary

1. There is essentially *no change* from the natural state in palatability, nutritive value, freshness or wholesomeness of meat properly packaged and frozen.
2. *Color* or bloom retention is the major problem to overcome but it can be maintained by the knowledge that we now have in packaging, freezing, distribution, storage, and retail conditions.
3. From a *Meat Science* standpoint, more answers related to the basic properties of muscle or meat are needed to simplify the processing problems.

LITERATURE CITED

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