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Introduction

The industrial manipulation of meat in the United States in the past was largely an art whose propagation was accomplished by information transferred from one generation to another by informal means. We had no guild system nor meat processing trade schools. One became knowledgeable in the meat industry by working in it and learning from the experience of his predecessors and perhaps from some of the adjunct suppliers who were free with advice - especially when it produced a market for their product. The Universities had little to do with teaching of meat processing principles or with processed meat research until after 1945. Even then, it is reported that teaching dealt largely with animal slaughter and butchering techniques and avoided almost completely the relationship of basic science to meat processing.

It has really been only in the past decade that Universities have become aware of the meat industries tremendous need for technically trained personnel to administer and to work in the areas of processed meat research, quality control and production.

Two recent developments in the food laws of the U.S. have amplified this need for technical personnel. The first was the 1967 law which places all meat processing plants in the nation under an inspection system similar to that formerly required only of plants shipping meat or meat products between the individual states. Technically trained people assist in guaranteeing that the

company for which they work complies with the many aspects of the new law. The second act which increased the demand for technically trained personnel was the recent 1969 act which limits the quantity of fat in some processed meat products. Product quality and economic considerations dictate that this legal maximum be approached but not exceeded, therefore control of raw material chemical composition is a necessity. Talk of microbiological standards, food additive reevaluation, nutritional declarations and pollution abatement lead us to believe that the need for technologists trained in the basic concepts of meat processing will not diminish in the near future.

A recent study (Rogers, 1969) shows that there are from 39 to 45 educational institutions in the U.S. offering courses in some phase of meat science. As near as we can determine about half of these have courses dealing wholly or in part with the science and technology of meat processing. Compare this, if you will, to a similar study made 10 years ago (Cahill, 1960) when only about 27 to 30 American Universities offered meat science courses and only 13 courses dealt with meat processing.

Though it was and is not by any means the leader in the teaching of meat processing among American Universities, the University of Wisconsin in Madison has offered a course entitled "Commercial Meat Processing" since 1961. It has been our privilege to have taught this course since 1963 and it is our desire to share with you some of the content and some of the goals of this particular University course.

Purpose and Objectives

The University of Wisconsin course in commercial meat processing

being is intended to cover in a general , yet workable , manner the areas involved in converting the animal carcass into a variety of processed consumer products. It does not concern itself with the slaughter , or fresh meat cutting operations , however.

By emphasizing the role of the fundamental principles of chemistry , biochemistry , physics , and microbiology the student develops an awareness of the basic nature of meat processing. Upon completion of this course the student is able to see the breadth of meat processing and to fit more specific and definitive courses into his overall technological education. By the same token if he does not choose to pursue specific technical training he is equipped to intelligently participate in a food company product control program , in production supervision or in many other beginning level positions.

Course implementation and prerequisites

The course as we teach it is geared to the undergraduate student who has satisfactorily completed college courses in general chemistry , general physics , general microbiology and an introductory course in meat science. Of course it is to the students advantage if he has had courses in food microbiology and introductory food processing.

In its current state, the course consists of 15 fifty minute lectures and 15 two hour laboratory periods. This is adequate for a general course , but hardly enough to cover in detail any specific topic. By cooperation among several university departments more advanced courses which apply directly to specific areas of meat and food processing are also available.

Subject matter and allotted time

<u>Subject</u>	<u>% of total time</u>
Basic Meat Science	20
Meat Microbiology and Sanitation	13
Heat Transfer	13
Processed Meat Technology	20
Packaging	7
Product and Quality Control	7
Research and New Processes	7
By Products	13

Although a detailed explanation of the total content of our general course in Commercial Meat Processing is beyond the scope of this paper it is summarized below:

Commercial meat processing

I. Basic Meat Science With Respect to Processing

A. Meat - definition and dynamic nature of meat

B. Chemical composition - general

C. Chemical composition - specific with regard to specie, tri-
mming type, age, grade, anatomy

D. Protein as related to processed meats

1. myofibrillar - nutritive, texture, adhesion, WBC and emulsi-
fiability effects.

2. sarcoplasmic - pigment, nutritive, emulsifiability and enzy-
matic effects

3. connective tissue - nutritive, gelatin formation, cost

4. non - meat protein - plant, milk, egg, blood - with respect
to above

E. Pigments

1. compare Hb and Mb - quantitative and qualitative differences
2. fresh pigment states - (OMb , RedMb , MMb), interaction, relative proportions of each, rate of MMb formation , photo - oxidation, bacterial oxidation , loss of reducing capacity , absorption and reflectance phenomenon , relation of pigment oxidation with flavor
3. cured pigment (NOMb, DenNOMb), reaction rates, oxidation , absorption and reflectance phenomenon
4. other pigment forms - COMB , CNMB , abnormal pigment forms
- F. Fat as related to processed meats
 1. nutritive, texture and organoleptic effects; cost; oxidation antioxidants
- G. Water
 1. natural
 2. added - replace natural lost in process; protein solubility; cooling; organoleptic; cost
- H. Other natural components important in processing
 1. lactic acid
 2. glycogen
 3. minerals - Fe , Ca , P
 4. vitamins - co-enzyme; reducing agent
 5. amino - acids - flavor; reducing agent
- I. Analytical techniques
 1. moisture - drying
 2. fat - ether extraction , Babcock , gamma ray , conductivity
 3. protein - Kjeldahl , dye binding
 4. other - NaCl , NO₂ , NO₃ , P , etc.
- II Meat Microbiology and Sanitation
 - A. Microbiological growth factors

1.nutrition

2.temperature - fresh and processed meat shelf life

3.oxygen tension - film effect, cry - o - vac aging

4.pH

5.water activity

6.curing ingredients

B. Organisms associated with meat and meat adjuncts

1.spoilage types

2.controlled fermenters - fermented sausage , lactic,
etc

3.food poisoning

4.Trichinella spiralis

C. Food hygiene

1.contamination sources

2.sanitation procedures

3.microbiological methods of analysis

1. Heat Transfer

A. General heat transfer

1.conduction - in a cylinder - loss and gain of heat

2.convection

3.radiation - infra red heating

4.energy transformation - microwave heating

5.heat exchangers

B. Thermal processing

1.chemical and physical changes in heated meats

2.principles of canning - process time calculation, retort
operation, common problems , pasturizing

3.sterile pouches

4.cooking - moist and dry air, water, effect on pro-

ducts, equipment

C. Refrigeration and cold storage

1. methods
2. product requirements

D. Freezing

1. chemical and physical changes in frozen meats on freezing and on storage
2. the freezing phenomenon - freezing curve, Btu calculation
3. methods - immersion, air blast, contact, cryogenic means, equipment

IV.

Processed Meat Technology

A. Curing and color development

1. chemistry of the curing reactions
2. role of curing adjuncts and other factors on color development
3. practical methods of curing

B. Non-meat ingredients

1. salt - action, purity, types
2. spices - history, types, action
3. binders
4. fillers

C. Sausages and loaves

1. history - types
2. emulsions - formation, stability, ultrastructure, etc.
3. formulation - factors influencing; such as emulsifying and binding ability, economics, product character, etc.
4. manipulative procedures and equipment - grinding,

chopping , mixing , stuffing , smoking , heat processing
etc.

D. "Smoked Meats" (ham , bacon)

1. unique factors in the production of smoked meats

V. Packaging

A. Packaging materials

1. types and composition
2. physical and chemical properties and their evaluation

B. Material selection and application

C. Labeling

VI. Product and Quality Control

A. Purpose and objectives

B. Federal standards and requirements

C. Statistical quality control

D. Common problems with processed meats

VII. Research and new or unestablished processes

A. Role of a research group - basic of applied

B. New or unestablished processes

1. freeze drying
2. gamma irradiation
3. continuous process systems
4. others

VIII. By Products

A. Definitions and scope of this area

B. Animal fats

1. chemical and physical properties - degree of saturation, melting points, crystal structure, plasticity, free fatty acids, etc.
2. rancidity and antioxidants

3. processing methods - conventional rendering, low temperature rendering, hydrogenation, refining , etc.

4. analytical procedures - proxide value, stability, free fatty acids, unsaponifiable matter , etc.

C. Commercial Products

1. gelatin and reformed collagen

2. tankage

3. enzymes

4. hydrolysates

5. other

D. Sewage and waste disposal systems

1. environmental pollution

2. systems

References

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- Rogers, R.W. 1969. Survey of Graduate Meats Courses. Proc. 22nd Ann.Recipr. Meat Conf. p.40. Nat. Live Stock and Meat Board, Chicago.
- Terrell, R.N. and L.L.Borchert, 1969. Commercial Meat Processing - A proposed Course Outline. Unpublished.