MEASURING OBJECTIONABLE INCLUSIONS IN PROCESSED MEATS*

PAUL P. GRAHAM
Virginia Polytechnic Institute and State University

Objection concerning the American meat supply is being heard from many quarters. Such criticism breeds uncertainty in the consumer's mind and leaves the meat scientist with the responsibility of reassuring these consumers that meat and meat products are wholesome, nutritious and safe.

How should one go about developing an expression of reassurance, especially an expression that will be published for the consumer to read? Perhaps, we should reveal the true facts, subject by subject, as they are attacked by those questioning America's regular food supply. But, looking at the increasing variety of foods that are continuously processed to a higher stage of convenience we find that this would be an insurmountable task.

So! Let's look at that one and one-half pound of sandwich meat that is used per household each week throughout the year. What objection could possibly be raised concerning this thin slice of meat product?

Well, the primary sources of ingredients for this sausage type product have historically been those parts of an animal carcass that could not be readily utilized in other ways. Thus, there has always been a certain degree of public skepticism concerning sausages. In fact, sausages may have been truthfully referred to as "bags of mystery" in some instances. Today, however, the production of sausage type meat products are as carefully scrutinized as any food. Yet, the industry is considered in essence a by-product one and questions continue to be raised.

Modern writers, like Richard Gehman in "The Sausage Book (1969)" support the art of sausage making and refute the "old mistaken notion that sausage is made from undesirable parts of meat, cut-off scraps, sweepings, or leavings." In the time allotted, would you join me in analyzing the facts known about the composition of your slice of luncheon meat.

What components could be objectionable?

The Manual of Meat Inspection Procedures of the United States Department of Agriculture describes the defects that may occur in boneless meat which is used as raw material for this type product. They are summarized as follows:

Defects in Meat Products

Extraneous materials in this case refer to those materials not directly related to the animal itself as it enters the slaughter operation.

Insects or parts thereof constitute a product defect according to the F.D.A. definition of adulteration (Sec. 420) which includes that a good shall be deemed to be adulterated:

1. If it bears or contains any poisonous or deleterious substance.

2. If it consists in whole or in part of any filthy, putrid, or decomposed substance, or is otherwise unfit for food.

3. If it has been prepared, packaged or held under unsanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health.

Rodent filth would likewise render the product unacceptable as would the items of glass, metal, plastic, or paper if they were to enter the product.

The act does not require that a food substance be injurious to health in order for it to be held filthy. It was designed to protect the consuming public from violations to its aesthetic taste and sensibility, as well as from poisonous, filthy, and decomposed food. Items deemed objectionable in a product but yet a part of the living animal are ingesta or fecal material; hair, wool or hide; and pinfeathers.

Moreover, integral parts of the carcass itself may be misplaced in a processed product and designated a product defect. Detached cartilage and ligaments or bone fragments become objectionable inclusions in sausage type products. Crushed or ground bone as such is not to be used as an ingredient of a meat food product (Section 318.14, Manual of Meat Inspection Procedures, USDA).

Blood, kidneys, and detached skin are not to be used in the preparation of such types of sausage as bologna, frankfurters, vienna, and braunschweiger. In addition, bruises one inch in greatest dimension or 1/2 inch deep and blood clots one and one half inches in greatest dimension are regarded as significant defects in boneless meat.

It is understood that the ingesta and fecal material are to be separated from the edible portion of the animal in the slaughter area and that all extraneous items are to be controlled in the further processing of meat and meat products.

But several of the defects that we listed have possible avenues of entry into products such as your luncheon meat.
Possible Sources of Defects

To keep hair off the exterior of the dressed beef carcass is a difficult job, but it is even more difficult to be certain of removal from the angles of the mouth. Visible hair roots are common to pork ears, snouts, lips and head fat and inverted hair follicles are simply just a part of pork jowls. It is important to note that unskinned pork jowls considered free of hair roots may be used to the extent of 50 percent of the meat formula in the preparation of frankfurter and bologna type sausages.

Cartilage and ligaments increase in product with the use of beef hearts, tongue trimmings and cheek meat. It is interesting though that mammalian bodies are constructed with one third of their total protein as collagen, largely in skins, tendons, and cartilage, but scattered generally as well.

Bone fragments are probable when neck, rib, vertebrae and head trimmings are used as raw materials.

Bruises may be found in all meat raw material classifications from time to time.

Blood clots are often found in the neck as a result of the penetrating captive bolt stunner used at the base of the skull. They may also be found in hearts.

How does the industry prevent the inclusions of these items in processed meats?

Primarily through Post Mortem and Boneless Meat Inspections.

It begins by visually observing or locating by palpation during the Post Mortem Inspection.

Careful head inspection can be effective in reducing product defects attributable to hair and bruises.

Viscera inspection yields clean raw materials for the manufacture of processed meats.

Final Carcass Inspections are limited also to a visual appraisal for hair and bruised tissue.

Boneless meat diverted to a further processing area is also visually inspected.
Inspection of Boneless Meat

The procedure is based on lot size as determined by the establishment.

The inspector must then secure the number of 12 lb. sample units designated by the appropriate sampling plan and inspect them thoroughly by visual examination. This is followed by a classifying of the defects according to critical, major, or minor and an action of acceptance or rejection of the lot.

Objectionable items that may have entered the product despite inspection and surveillance of both meat inspection and company personnel become essentially impossible to detect by visual inspection, thus samples are submitted to the laboratory for examination. Such samples are generally taken from the finished product but if it deems necessary, investigational samples may be collected at any point in the operation.

Separation of the various objectionable inclusions are attempted by methods such as the A.O.A.C. method for determining light filth in sausages. By this method sausages are teased apart using 10% Tergitol as a stirring medium and then the components are separated by sives and standard flotation practices.

Microscopic examinations may be utilized to establish the presence of certain components such as organs, ears, snouts, viscera, etc., in sausage samples. An adequate background in histology is required and difficulties are encountered in identifying non-skeletal components when high speed emulsifying grinders are used for processing. These manufacturing practices often change the morphological pattern of many tissues. For example, the shape of conical papillae are destroyed without prior cooking whereas with conventional type choppers the identity of the papillae is possible unless the lips have been cooked and the mucous membrane have been removed.

Microphysical procedures have been used for the extraction of insects, filth and bone from prepared foods and raw materials. Screening and filtering techniques have been used to separate bone and coarse particles from sausages. A number of reagent combinations of ether, mineral oil, gasoline, heptane and carbon tetrachloride can be used to separate according to the density of the components. Gensler (1922) reported results from several cooperating analysts in the determination of bone in meat products. Variations were 0.5 percent in Sample 7 and 1.6 percent in Sample 8. The procedure used was a flotation procedure using chloroform as the flotation liquid.

One of the more pressing problems associated with measuring objectionable inclusions in meat products is that of freeing the individual components from the mass so that they can be identified. Techniques have been reported by several workers which employ alkali digestion of soft tissue to expose bone, collagen and elastin materials (Diller, 1941). Success has also been reported by Hill and Hites (1968) with a procedure they attribute to a
combination of the principles employed by several previous authors. In 
their procedure, the bulk of the meat is solubilized by digestion with 
papain and the bone is separated from the other nondigestible material 
according to its ability to settle in a carbon tetrachloride:acetone 
mixture.

A chemical approach to quantitating the defect items also has 
limitations particularly since size or amount per location enters into 
the evaluation of usability of the product. Chemical determinations of 
the ingredients which are expected to be in the product may be made to 
find out if they are used in quantities greater than necessary. The 
excessive addition of water, starch, cereal and soya flour are examples 
of adulteration of meat products. Horse meat may be identified by 
analyzing the amounts of glycogen present in the flesh. However, the 
glycogen content must be upwards of 2% (dry matter basis) to be considered 
a positive test.

With the recurring interest in horse meat, its presence may also be 
determined by treating with formalin upon which an intense and characteristic 
odor, suggestive of roast goose, will develop.

As with other specie identifications, the specific test is a biological 
one. In fact, the technique of serology can quantitatively assess specific 
proteins present in a mixture. But, in the case of sausages, heat processing 
may denature the proteins of the meat and negate the specie-specificity of 
the antiscrum.

Washing or exposure of the sample to various liquids will elute some 
components which may then be subjected to further separation and identifi-
cation. Water-insoluble proteins such as found in heat processed meat 
were identified as to species of origin by Mattey et al. (1970).

Considering the difficulties encountered in the physical breaking up 
of cooked sausage products no one can measure the defect items themselves 
and the fact that denaturation has occurred, we must turn to methods of 
defect analysis that indicate the presence of the tissue. In the case of 
blood, visual and organoleptic inspection yields, at best, only presumptive 
evidence of its presence. Hankin (1965) reported a quantitative method 
for determining blood added to uncooked hamburger. The analysis was 
based on blood being eluted from the sample with water, oxidized with 
hydrogen peroxide to liberate iron from the hemoglobin, and then treated 
with sodium tungstate to precipitate proteins. The iron content was 
measured by the thioglycolic method.

The determination of unacceptable blood (including bruises or blood 
clots) in a cooked sausage product is again more difficult since very 
little protein is soluble after cooking and according to Tekman and Oner 
(1966) blood serum samples heated at 75°C. showed no migration of any 
protein fraction when subjected to an electrophoretic system. The NaCl 
precipitation technique reported by Tybor et al. (1970), offers a useful 
method for recovering heat denatured proteins in bovine serum. Albumin,
past albumin, transferrin, and globulin showed different individual
denaturation responses to heat as monitored by electrophoretic analysis.

The use of biological iron compounds as indirect indicators may
also have merit. Iron appears in the vertebrae in four major forms.
Each of these can be easily separated and identified.

Ferritin--storage iron--found in spleen, liver and bone marrow--
protein encapsulated iron.

Hemosiderin--a massing of ferritin units--found in spleen, liver and
bone marrow. Resists bleaching and does not dissolve in alkalis or acids.

Transferrin--iron binding protein for transport in the blood.

Respiratory or Heme--myoglobin of cells, hemoglobin of blood.

Gresham et al. (1971) have reported a rapid separation of these
four iron containing compounds. Hemosiderin is first separated from
the others due to its water insolubility. A unit of this compound is
approximately 6 microns in size and appears golden under light microscopy.
Selective staining for trivalent iron w/Perl's stain produces large blue
granules which probably would lend well to spectral quantitation.

Ferritin is selectively precipitated from the supernatant with
ammonium sulfate and can be easily crystallized with cadmium sulfate.
Crystalline ferritin is commercially produced from horse spleen. It is
used in electro-microscopy as an electrodense tag for antibodies.

The aqueous portion is then partitioned against methyl ethyl ketone.
Heme irons are extremely soluble in this solvent. Transferrin remains in
the aqueous phase. The Heme irons, myoglobin and hemoglobin can be
electrophoretically separated and quantitated.

When considering the variability in meat it appears hopeless to
base anything on hemoglobin and myoglobin. Myoglobin densities vary
between species, animals, and muscles. Beef has more than pork, as
indicated by its deeper red color. Muscles that are used most frequently
contain the most myoglobin. Blood retained post slaughter varies not
only by species but by the cuts used--that is, thick cuts such as round
will retain more blood due to vessel size than will thin cuts such as
navel or plate.
Summary and Conclusions

1. Extraneous materials, inedible animal products and inappropriately used meat and meat by-product tissues are considered objectionable inclusions in meat products.

2. Avenues for entry are possible even under the best manufacturing practices.

3. Current quality control and regulatory procedures are generally limited to visual appraisals of randomly selected samples of raw materials for the processed products.

4. Laboratory methods for detection are generally laborious and quite lengthy.

5. The challenge before us is to develop satisfactory rapid methods compatible to the quality checking or rapidly merchandized products. Such technology will supplement the inspection and surveillance of the meat inspector and add confidence to the consumer that she is buying only those things that are identified on the label.

Defects in Meats Products

1. Extraneous materials
   a. Insects
   b. Rodent filth
   c. Glass, Metal, Plastic, Paper

2. Ingesta or fecal material

3. Hair, wool or hide; pinfeathers

4. Detached cartilage, ligaments

5. Bone fragments, bone slivers

6. Bruises

7. Blood clots
### Possible Sources of Defects

<table>
<thead>
<tr>
<th>Defect</th>
<th>Raw Material</th>
</tr>
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<tbody>
<tr>
<td>Hair</td>
<td>Brain; lips; poll meat; ham facing; pork cheeks; pork fat; pork jowls; pork ears, snouts and head fats</td>
</tr>
<tr>
<td>Cartilage and ligaments</td>
<td>Beef heart; beef heart meat; tongue trimmings; cheek meat</td>
</tr>
<tr>
<td>Bone</td>
<td>Brain; neck bone trimmings; rib trimmings; vertebrae trimmings; head trimmings</td>
</tr>
<tr>
<td>Bruises</td>
<td>Skeletal muscle; poll meat; ham facing; ears, snouts, lips and head fat</td>
</tr>
<tr>
<td>Blood clot</td>
<td>Neck; brain, heart (beef, pork)</td>
</tr>
</tbody>
</table>

### Prevention of Objectionable Inclusions

1. Post mortem inspection
   a. Head inspection
   b. Viscera inspection
   c. Final carcass inspection

2. Inspection of boneless meats

### Inspection of Boneless Meats

1. Determine lot size
2. Select applicable sampling plan
3. Secure the required number of 12 lb. sample units
4. Inspect thoroughly (visual)
5. Classify defects
Laboratory examination

1. Physical determinations
2. Microscopic examination
3. Histological and histochemical techniques
4. Chemical analysis
5. Biological testing

Determination of Bone in Meat Products

<table>
<thead>
<tr>
<th>Analyst's no.</th>
<th>Sample 7</th>
<th>Sample 8</th>
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<tbody>
<tr>
<td></td>
<td>Actual bone present, %</td>
<td>Determined bone present, %</td>
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<tr>
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<td>8.4</td>
<td>8.3</td>
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<tr>
<td>Variation</td>
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</table>
LITERATURE CITED AND OTHER REFERENCES


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S. SIMON: Thank you, Paul.

Ralph Johnston is senior staff officer of the Food Microbiology group, Animal and Plant Health Inspection Service of the U.S. Department of Agriculture, Meat and Poultry Inspection Program. His academic training in biology and bacteriology were obtained at the University of Akron and Ohio State University, respectively. Before joining the USDA at Beltsville in 1966, he gained prior professional experience with the Ohio Department of Health and Ohio Department of Agriculture and the Food and Drug Administration. In recent years, Ralph has devoted his professional activities to microbiol standards in foods which qualifies him to discuss the topic, "Microbiological Standards in Processed Meats."