Raw Material Utilization – A Global Perspective

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Topic Summary

I was asked to focus on the utilization of a few non-traditional meat raw materials in meat processing. These are typically non-skeletal meats. The use of these materials is affected by several factors to be discussed in the next section. But it should be emphasized that some useful generalizations should not be regarded as absolute.

The primary concerns for us as meat scientists should be about 1) how to use materials that could otherwise be regarded as waste, 2) how to add value to relatively low-value inputs, and 3) how to develop and position new products (traditional and exotic).

Taken together, these considerations enable us to become better at helping the food industry in general, and the meat industry in particular, to provide affordable products that satisfy the nutritional and experiential needs of our increasingly diverse and growing population of consumers.

Factors That Influence Choice And Use

The raw materials of interest here are typically non-skeletal meats and other tissues. Their utilization in meat processing is determined by a number of factors ranging from local food habits/preferences to the availability of technology for handling. The following is a short discussion on the relative impact of certain factors on the use of these raw materials.

1. Economics

In most places where non-skeletal meats and other tissues are used in processed meats, the primary motivation is usually economic. With relatively low consumer purchasing power, coupled with the high price of skeletal muscle meats, processors are driven to use organ meats, skins, mechanically separated meats, etc. to augment their meat supply in order to produce affordable products.

If we were to take the literal definition of meat as “edible tissue derived from livestock . . .”, then the utilization of these non-traditional meat tissues would not merit any special attention. Due to disparities in economic status and differences in local preferences, some people are compelled to use these materials in the production of processed meats while others choose not to.

As people’s economic status begins to edge upwards, they have the tendency to become a bit more discriminating in their tastes and choices—in short, they become more willing to pay more for “the real thing”, whatever that may be.

2. Local Preferences

Economic considerations notwithstanding, there are quite a few processed meat products made out of non-traditional raw materials for reasons of preference. Blood sausage, head cheese (souse), pâtés and liver sausages, chicharrones (pork crackling), to name a few, are very popular in certain countries and regions and among certain ethnic groups.

While the utilization of these tissues for food may have had more humble origins, many of them have become delicacies and highly sought after specialty products. Head cheese, as an example, was developed as a means of using up all the variety meat generated by home slaughter. It contains head meat, tongue, heart, feet, gelatin, etc. and has since become an industrial product.

An interesting twist to both the economic and local preferences considerations is the fact that in China, it would be unthinkable to consider pork variety meats as low-cost alternative raw materials for meat processing since they are actually regarded as delicacies and cost more than skeletal muscle meats! Table 1 lists a few such ingredients, the countries where they are used, and the products made with them.

<table>
<thead>
<tr>
<th>Product</th>
<th>Non-Typical Raw Material</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Pudding (Blood Sausage)</td>
<td>Blood</td>
<td>England</td>
</tr>
<tr>
<td>Pâté</td>
<td>Liver</td>
<td>France</td>
</tr>
<tr>
<td>Zampone</td>
<td>Skin</td>
<td>Italy</td>
</tr>
<tr>
<td>Mortadella</td>
<td>Cow udder/Stomach</td>
<td>Italy</td>
</tr>
<tr>
<td>Chicharrones</td>
<td>Pork Skin</td>
<td>Mexico</td>
</tr>
<tr>
<td>Frankfurters</td>
<td>MDT</td>
<td>U.S.</td>
</tr>
</tbody>
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3. Legislation

The use of these raw materials is greatly affected by local legislation in most countries. The legislative constraints cover not only the actual use of some of these materials but also the levels of inclusions and how they are identified on the labels.

In Spain, hydrolyzed collagen is added to ham brines to meet moisture:protein regulations at increased injection levels. In England, dried skin granules are added to sausages to meet minimum meat content requirements. Fresh skin counts as 130% meat in England. In the U.S., heart meat is labeled as “heart”, and in the interest of maintaining a ‘clean’ label, some processors choose to avoid using it. Also in the U.S., poultry MDM can be used up to 15% without front panel declaration. It must, however, still be in the ingredients statement. In Brazil, MDM inclusion is limited to 20%.

Because plasma is labeled as, say, “beef blood plasma” in the U.S., its use is more limited here than in Canada, for instance, where it could be labeled as “meat protein”. With the growth in demand for low- and reduced-fat products, fat is usually replaced by water, sometimes making water the number one ingredient on the label. If, however, the water is added as hydration water for beef broth, it could escape mention, since the material could be labeled simply as “beef broth” (despite the up to 1:137 possible hydration ratio!)

4. Technology

With advances in meat processing technology, it is becoming easier to incorporate certain raw materials into processed meats. Pork and chicken skin are the most obvious discussion candidates here. Without meat grinders, bowl cutters, and emulsion mills, the use of skin in comminuted meat products would be nearly impossible. While cooking or soaking in acid will soften skin, it is still essential to grind and chop it in order to produce the so-called skin-emulsion or skin curd—the most popular addition method.

Co-extrusion sausage technology makes it possible to coat sausage batter (in rope form) with a collagen ‘dough’ made from the inner layer of cattle hides or hog guts. And suspension technology allows the incorporation of pork-trimmings into hams. Of course, the trimmings are meat, and do not count towards the “percent-added substance” under the PFF classification.

5. Raw Material Balance

In many cases, it is simply prudent to develop ways of utilizing these non-traditional raw materials in order to maintain a balance in the production and sale of meat ingredients. The opportunity to use more of the meat animal than just the skeletal tissues offers both economic and, at times, materials handling balance. Use of poultry MDM, chicken and pork skin, and blood creates economic advantages by adding value to materials that could otherwise be treated as waste.

Also certain organ meats—liver, kidney, and heart, due to their high color values—could be used in certain applications to augment lean meats to give more acceptable processed meat color.

Table 2 illustrates several points of interest. In the two formulas shown, (from a Latin American country), the use of non-skeletal meats in a frankfurter is demonstrated. It is interesting to note that the overall formula cost can be reduced and quality (proximate and organoleptic) maintained by manipulating the levels of these ingredients. Pork heart, which is a delicacy in this country is relatively more expensive than other meat ingredients and so, is reduced during reformulation. The percent cost reduction of almost 9% is very significant when applied to the large quantities of this product manufactured annually by one processor.

### Selected Examples Of Non-Skeletal Meat Raw Materials

**Mechanically Deboned Meat (MDM)**

This material comes from different species—chicken, pork, beef—and can vary widely in composition. While it may contain a preponderance of skeletal meat, it is being discussed here because it could also contain other tissues such as bone marrow, bone powder or fragments, and skin. The most common type is chicken MDM.

The composition of MDM may be 13-15% protein, 65-70% fat, and nearly 1% ash. It contains some heme from bone marrow, and this can improve the color of a cured product. However, it is prone to oxidation or rancidity, due to its lipid and heme content. French MDM producers combat the twin problems of rancidity and microbial contamination through freezing and irradiation.

In the U.S., the words “mechanically separated (specie)” must be used in the ingredient list on product labels. If skin is used in excess of natural proportions, the qualifier “with excess skin” is required.
The 40% rule in the U.S. allows greater than 10% added water in cooked emulsion products. This regulation will allow greater use of high-moisture MDM, especially in the cooler months, when MDM moisture is usually higher.

In summary, MDM is an inexpensive meat ingredient of relatively high protein quality with some disadvantages, such as limited storage life (prone to lipid oxidation), high moisture content, bone fragments, and low water-holding capacity (see Table 3).

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inexpensive</td>
<td>1. Small particle size - limits use</td>
</tr>
<tr>
<td>2. Can add color</td>
<td>2. Soft texture</td>
</tr>
<tr>
<td>3. Improves carcass yield</td>
<td>3. Higher lipid content</td>
</tr>
<tr>
<td>4. High quality protein</td>
<td>4. Prone to oxidation</td>
</tr>
<tr>
<td></td>
<td>5. Cell maceration compromises water-holding capacity</td>
</tr>
<tr>
<td></td>
<td>6. Possible bone powder/fragments</td>
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</table>

Table 3 Advantages and Disadvantages of Using MDM

Skin (Pork, Chicken)

Pork skin is used as a sausage ingredient all over the world, but not in the U.S. Here, chicken skin is more commonly used. Gelatin from skin and other tissues (bone, tendon, connective tissue) is a more value-added material that is widely used in the U.S. Pork skin is used in three principal forms—raw, cooked, and dried.

Raw Skin is processed into an intermediate ingredient through chopping and emulsifying. This ingredient, known as skin emulsion or skin curd (Asia) is made out of skins and water in a 1:1 ratio, stored and used as required. Long chilled storage results in settling out of moisture—creating two phases. Addition of isolated soy protein helps to stabilize this material and prevent the separation. This material can also be frozen and treated like other frozen meats. Skin emulsion is commonly used in Japan, South Africa, Spain, France, Brazil, and most of Latin America.

An interesting example is the use of the lower leg skin and pieces of skin for Zampone and Cotechino in Italy. For Zampone, the lower leg/foot of the pig is cleaned out and the meat is removed. The skin and pieces of skin are sewn together to encase the meat. For Cotechino, pieces of skin are sewn together to encase the other ingredients. After retorting at the factory and cooking for home preparation, the skin and the internal ingredients are cut and eaten. The Zampone in Italy is something like the turkey or ham for holidays in the U.S.

Cooked Skin is a little less popular. The purpose of the cooking is to soften the skin. The cooked skin is chopped hot with additional water. The cooking and chopping converts enough collagen into gelatin, which upon chilling, becomes a firm gel. Skin-on jowls is a characteristic raw material for use in pâté to add some textural characteristics. Soaking in acid (citric acid or even acid phosphate) can also soften the skin. The acid is washed off before further handling. This is cumbersome and consequently not widely used.

Dried Skin, usually in granule form, is soaked before use. The drying process is essentially like rendering. The granules can be tumbled into hams and counted as meat.

Skin contributes good texture to products that are served chilled, such as bologna and mortadella, where up to 20% of skin emulsion could be used. Products that are reheated prior to serving, such as frankfurters, usually should contain not more than 10%.

There is no accepted or fixed fat content for pork skin. It ranges from about 10% to greater than 30%. It is always necessary to know the fat content of the skin available for use for good product formulating.

Chicken skin is used in sausages, chicken nuggets, and patties. Its main value is in boosting the typical chicken flavor, juiciness, and for cost reduction. On the downside, it has the tendency to impart a slightly off-white color to these products. During frying and reconstitution, ground skin may break down to fat and gelatin, resulting in small pin-holes and a spongy texture. Additionally, skin contributes to increased microbial risks, especially when the product is not fully cooked and it promotes oxidative rancidity.

Blood Plasma

Blood plasma is extracted from the blood by a separator at the slaughterhouse and is used fresh, frozen, or dried.

In the fresh liquid form, it is a highly perishable product with considerable risk from bacterial contamination and a limited storage life. It contains approximately 8-9% protein, with solids content of 10-12% (salts, sugar). The rest is water. It can count as meat in formulation.

Usage is limited to about 1% solids (10% formula) before flavor becomes limiting.

Plasma is frequently added frozen, partially thawed. It adds a good binding protein, aids in temperature control, and can be called ‘pork’ in Denmark and France.

By spray-drying, dry plasma is produced. It is a light-yellow product with a protein content of about 70%. This is a valuable protein additive for inclusion in processed meat products, providing good binding characteristics.

In the U.S., it is labeled as “beef blood plasma”, while in Canada, it can be labeled simply as “meat protein”.

Partially De-fatted Tissue

Partially de-fatted tissue (beef and pork) is produced by low-temperature rendering of meat fatty tissue with initial visible lean of at least 12%. After rendering, the finished material contains about 70% moisture, 20% protein, and 10% fat (with a considerable amount of collagen). The fat from the original tissue is made into lard or tallow, and the “stick water” or broth can be used in sausage manufacture. When dried, the broth contains up to 95% protein (mainly collagen and myoglobin).

The partially de-fatted tissue can be frozen or dried. It
is a source of collagen and fat, and because it is produced through a process involving heat-treatment, it is prone to rancidity (fat-oxidation). So, use of antioxidants is recommended. Use of partially de-fatted tissue in the U.S. is limited to 15% of the meat block in cooked sausages.

**Variety Meat (Offals)**

These include organ meats such as liver, kidney, heart, lung, spleen, and salivary glands, and tissues like stomach and cow’s udders. Generally, these have poor binding qualities and are used mainly for economic reasons as sources of cheap meat.

In addition to the economic considerations, there are some functional and tradition-based reasons why some of these are used in processed products.

Liver is quite popular in pâtés and liver sausages. Flavor and texture contribution are usually poor in sausages. Heart and liver have high color values and augment lean meats to give good color scores. Cow’s udders are used in Italy as a cheap raw material for making industrial mortadela for products like ravioli. Others such as kidney, spleen, salivary glands, and stomach are used solely for economic reasons.

**Miscellaneous (Mutton, Horse meat, Fish)**

Though these are not non-skeletal or low-functional-ity raw materials, it is interesting to note that processed meats in certain parts of the world contain significant quantities of them. Availability and local preferences are the driving forces behind their use.

In Japan, mutton, horse meat and fish (usually in the form of surimi) are common ingredients for sausage and pressed ham products. In New Zealand and Australia, where a lot of lambs are raised, use of mutton in sausage-making is fairly commonplace. In the Middle East, because of religious and taste-preference reasons, use of mutton in processed meats is also popular. Even in Mexico, next door, it is becoming increasingly difficult to see a “ham product” made only of pork. In fact, it is easier to find such products made out of horse meat (affectionately called fast-beef!), turkey MDM, and some pork fat.

**Conclusion**

The meat processing industry is constantly seeking ways to utilize more of the meat animal. The use of non-skeletal tissues goes a long way towards satisfying needs such as cost containment, raw material balance, and satisfaction of local preferences.

As technologies, legislation, and demographics continue to evolve, the use of these tissues will continue to expand. The overall objective we all have, of feeding the world, will be that much closer to attainment.

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**References**