In view of the widespread interest in mechanically deboning and mechanical separation of meat from bones some guidelines to assist in evaluation of available machinery may be useful.

The deboning machines currently available fall into three types:

1. Auger and screen: a close-fitting auger or screw within a cylindrical screen works the product through fine perforations or slots in the screen. Examples of these machines are the Beehive, Yieldmaster and Paol.

2. Belt and screen: an elastic belt works the product through perforations in a rotating drum screen. Examples of these machines are the Baader and Bibun.

3. Press and screen: product is worked through a slotted or perforated screen by a hydraulic ram and by shear between the bones as they are compacted. Machines of this type include the Hydral, Protecon and Injectstar.

FACTORS IN CONSIDERING MECHANICAL DEBONING

Capital costs

The cost of the deboning machine may be only a fraction of the total cost of setting up a deboning facility. Other considerations are:

- The cost of providing 'edible' standards a room large enough to contain the machine and any necessary ancillary equipment.
- The cost of any required breaking equipment, such as cutters or grinders.
- The cost of conveying systems and suitable containers for input material, waste bone and separated meat.
- The cost of refrigeration equipment specifically required for the deboning operation. A holding chiller may be needed to ensure low temperature of input material.
- Packaging equipment may be needed and will add to capital costs.

Operating costs

There will be a variety of costs associated with the deboning operation, including labour, energy, packaging materials, quality control and analytical costs. Cleaning costs may be high, especially if skilled labour is required to disassemble and reassemble the machine.

Repairs and maintenance

Some of the deboning machines have parts of relatively short operating life. The anticipated and actual life of these parts, and their availability and costs, will affect repair and maintenance costs.

Cleaning

The frequency of cleaning and the downtime necessary for cleaning operations will influence the throughput of the machine and will greatly influence operating costs. It is difficult to determine how often a machine will need cleaning. This will depend, in part, on the possible build up of 'stagnant' pockets of material. Temperature rises in this material would create contamination sites and necessitate frequent cleaning.

Input material

The input material will determine the composition and quality of the recovered meat. It may also influence the overall performance of the deboning machine.

Since any holdups before processing can lead to increases in microbiological load and a decrease in the functional properties of the mechanically recovered meat it is important to process bones as soon as possible.

Throughput and yield

Machinery manufacturers often quote throughput as kilograms of input material per hour. Consideration should be given to how often and for how long the stated capacity can be achieved. It is important to establish as accurately as possible the probable throughput over an extended period, say a week, taking into account raw material type and availability and realistic estimations of machine downtime.

The in-feed arrangements, type of bones and their pretreatment will affect throughput and could influence choice of machine for particular situations.

Yield is sometimes given without any explanation as a percentage. Yield as a percentage of input material recovered in the meat stream will vary greatly, depending on the input material. A more meaningful figure is the percentage of potentially recoverable meat that is actually recovered in the meat stream. It is not easy to ascertain accurately how much meat is on the input bones but a rough approximation can be gained if the ash content of the input bones is known:

\[
\% \text{ meat on bones} = 100 - [4 \times \text{ash content (\% wet weight)}]
\]

Product composition

Product composition depends on the raw material, its pretreatment, and on the machine itself. For example, if input material has a high ash content the...
mechanically separated material also will have a high ash content.

Composition is also influenced by the tendency for water to be pressed through the screen, so moisture content of mechanically separated meat is generally higher than for whole tissue meat.

Calcium and bone particle content depend on both the prebreaking and the deboning machines used. With auger and screen or belt and drum machines, the prebreaking treatment can increase the quantity of bone fines in the product.

The quantity of marrow in the product is determined by the composition of the raw material and by the machine type. Auger and screen machines tend to force more marrow from hard mature bones into the product than do other machines, but marrow levels of product from young soft bones can be high regardless of machine type.

Marrow composition varies among bones, and also with the age and species of the animal. Marrow from long bones has a higher lipid content than marrow from flat bones, ribs or the spinal column. Bone marrow lipid has more polyunsaturated fatty acids, more phospholipids and more cholesterol than subcutaneous or intramuscular fat. In practice this means that product containing this material will be more prone to deterioration from oxidative rancidity.

Chemical analyses

Chemical composition data are often presented for mechanically separated meat. It is very important when comparing data obtained under different conditions that the data are all on the same basis. Data may be presented on a basis of wet weight, dry weight, fat-free wet weight, or fat-free dry weight. Interconversion of the various forms of presentation is possible if complete analyses are given.

Calcium content can be determined by analysis but a handy approximation is that calcium makes up approximately 38% of the ash content.

Bone particles

Aside from consideration of calcium content and nutritional implications, the size of bone particles in the meat stream is also important. Readily detectable bone particles will bring the possibility of lost or discounted sales, or possibly consumer claims for dental repairs. Further product processing such as homogenization and cooking may decrease any 'grittiness'.

Temperature rise

Temperature increases in the product can occur during pretreatment and during deboning operations. The rise in temperature is greatest in auger and screen machines (up to 13°C) and least in belt and screen machines (2-3°C). Some means of product cooling during the deboning operation is advisable, especially with auger and screen machines.

The temperature of the raw material and product streams should be kept as low as possible. This will minimize loss of functional properties and change in microbiological status.

Hygiene

Any pockets of 'stagnant' material within a machine will serve as possible sources of continual contamination of product especially if they are in warm spots, which favour microbial growth. The frequency of required cleaning operations would be greatly influenced by such pockets. Microbiological examination of the first material through a machine after a break in processing would provide an indication of machine hygiene.

Product texture

Texture of the recovered product is not the same from all machines, varying from a smooth paste to a fibrous material. The texture of mechanically recovered meat is finer than that of ground meat because some connective tissue is removed during the deboning operation. Final texture is determined by the size of the holes in the screen through which the
meat is forced. A range of screens is available for some machines, allowing texture to be altered (yields and bone particle size will, of course, vary according to screen-hole size). Texture may be very important, depending on the projected use of the recovered product.

**Product handling**

Ideally, mechanically deboned meat should be used for further processing immediately after recovery. Where this is not possible it should first be cooled, then frozen as quickly as possible and stored at -20°C or lower.

To minimize the time the product is held at elevated temperatures the deboning head should be cooled and the product transferred immediately to a cooling environment. Fast cooling can be achieved with a scraped surface heat exchanger, a carbon dioxide snow cooling unit, or by blast freezing in thin layers; immersion freezing in 'chubs' or plate freezing. A processor considering purchase of a scraped surface heat exchanger should buy one made specifically for the purpose.

**Uses and markets**

Mechanically recovered meat can be used as an extender in minced meat and hamburger patties, and as an ingredient in manufactured meat products, canned meat products and meat pastry goods. Markets need to be carefully considered because of the short storage life of the recovered meat.

**Regulations**

Various countries have or may impose specific regulations governing importation and use of mechanically separated meat. For example, the United States has regulations on calcium content, bone particle size, fat content, raw material and product handling, hygiene, product uses and labelling.

**Further reading**

Goldstrand, R.D. (1975)
Mechanically deboned meats. Yields
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