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Preparation of Bone Stock

Bone stock is a generic term covering the variety of products that are produced as concentrated extracts, and are derived wholly, from bones. The products vary depending mainly on the raw materials used for extraction. Traditionally these products have been prepared solely from beef femur bones with the highest value stocks.

Bone-stock markets

The outbreak of BSE in cattle in the Northern Hemisphere and the resultant concerns surrounding beef consumption, appears not to have significantly affected the beef bone stock market with strong levels of support noted for these products within the culinary trade in both Europe and North America. The variety of products available on these markets is extensive.

While the major markets for bone stock appear to be in beef bone stock, there is no reason why stocks cannot be produced from the bones of sheep and other species. The addition of stocks from species other than beef could provide some interesting flavour alternatives to the culinary trade.

Bone stocks have an established mature market in Europe and a developing market in the USA. Asia has an established market that was identified as having a value, in the early 1990s, in excess of $50 million (USD) and showing extraordinary growth. A major part of this market is supplied from within Asia, with Thailand being the major producer with an estimated 40% of the market. Australia is seen as an ideal supplier of stocks to this market, with its 'clean, green' image and current 'BSE free' status. The high protein content and shelf-stable nature of these products make them ideal for markets in developing countries with limited infrastructure for handling chilled and frozen meat products.

Bone stocks are used in a wide range of food industry applications including:

- instant soup manufacturing;
- dry, and paste, seasoning ingredients;
- ramen noodle soups;
- home and restaurant soup bases;
- bases for all types of home and food service cooking.

Product specifications

Bone stocks are generally produced to an individual client's specifications with a significant variation in physical attributes and composition possible. Colour is often an important attribute so the removal of meat pigments is an important part of the process.

As bone stocks are formulated to meet customers specifications, there is significant opportunity for value adding by blending in other components to improve flavour and texture during concentration of the extract. Typical additives are salt, fat and malto-dextrins. Typical product attributes are given in Table 1.

Table 1. Typical Beef Bone Stock

Appearance & Odour	**Creamy to light brown paste with a mild beef odour**
Total Solids	66% +/– 3%
Protein	28% +/– 2%
Salt	12% +/– 1%
Fat	26% +/– 2%
Coliform	Negative
Total Plate Count	< 100 cfu/gram

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Bone stock processing

Figure 1 shows the process for preparing bone-stock extracts.

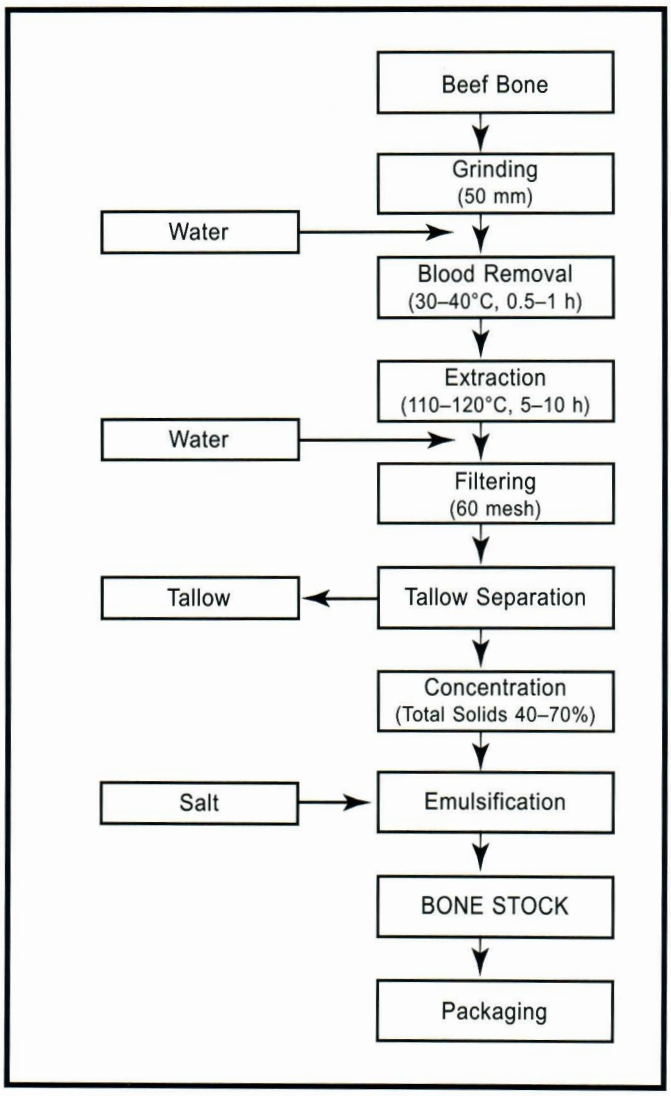
Raw material preparation

Bone stock can be prepared from fresh or frozen bones. Bones are prepared by firstly selecting the required types of bones, for example femur bones—if the product specification requires only this type of raw material.

If necessary the bones are cleaned of excess meat. While many bone stocks utilise the residual meat on the bones, some stocks require a minimal level of myofibrillar proteins so residual meat must be removed. Stocks from clean bones tend to be low in myofibrillar proteins but high in gelatine.

In regions where labour is inexpensive, bone cleaning is often carried out manually. Mechanical deboning is not suitable as the mechanical deboning process removes a large proportion of the bone marrow along with the residual meat tissue. Also the bone 'cleaning' effect is relatively inefficient, leaving a significant proportion of tissue material still closely mixed with the bone. Other bone 'cleaning' systems have been investigated with high-pressure water cleaning appearing to be a promising technique.

Figure 1. Schematic layout of the bone-stock process.



Size reduction

Bones are pre-broken and minced to a coarse size. A coarse grind size is used so that a minimum of fine bone particles that can pass into the bone stock, is produced—while not limiting the release of any residual fat, muscle protein and bone marrow material. A grid size of up to 50 millimetres is normally used.

After particle-size reduction the bone is mixed with water to allow for adequate heat transfer and phase separation during cooking. Meat to water ratios are normally around 1:1.

Pigment reduction

A pale colour is seen as a desirable attribute in most bone stocks so the process normally includes a blood removal step. The bone/water mix is heated to 30–40°C and held for 30–60 minutes under gentle agitation. Water is drained and replaced several times during this time to wash out as much blood pigment as is required.

Cooking

The temperature is then raised to boiling point to cook the bones and extract the protein and fat components. This extraction will normally be through atmospheric boiling, at 100°C, but can also be through boiling under slight pressure to raise the temperature to about 110°C. Cooking times vary from 5 to 10 hours depending on the product required, the initial particle size and the raw material used.

Separation of phases

The separation of liquid and solid phases is carried out using a moderately fine sieve. Sieving removes the bone particles and any coarse meat particles. Fine meat particles are allowed to pass through with the liquid phase. Any large meat particles are returned to the cooking vessel for further processing.

Tallow may be separated from the liquid phase stream in a centrifugal separator with fines returned to the main stream of the watery bone-stock phase. Alternate techniques, such as gravity settling, may be suitable if a higher fat content is required, or is acceptable, in the final concentrated stock.

The bone material is now very 'clean' and may be suitable for other processes such as the production of photographic-grade gelatine. If no further use is identified for the material, it can be returned to the rendering process for inclusion in meat meal or in blood and bone fertiliser.

Stock preparation

The watery stock is then concentrated, as for meat extracts, using a Multiple Effect Evaporator to flash off moisture under vacuum and increase the solids content. The output solids content of the multiple effect evaporator is limited because the solution becomes too viscous to flow readily through the evaporator tubes without fouling. As the stock is high in gelatine and can become quite viscous, the solids content may be limited to only about 20–30% solids. In some instances, when the stock is required for local use, the

concentration stage is minimal to produce a low-solids stock that is chilled for short-term use.

As the stock may still contain a significant content of small meat particles, and may have a high fat content, it is emulsified. Emulsification blends the fat and water together into a creamy stable emulsion while reducing the meat particles' size to become homogeneously suspended through the concentrated stock.

Salt, or other materials, may be blended into the concentrate at this stage—prior to further concentration in a pan evaporator. This secondary concentration continues until the solids concentration is around 60–70% and the stock is stable at room temperature. The final solids content will depend on, primarily, the salt content of the stock. Other materials added can include malto-dextrins to impart additional and unique flavours through reactions with the soluble proteins during the final evaporation process.

Stock is normally packed as a thick paste in plastic pails or plastic-lined drums.

Powder preparation

The concentrated stock can be dried to form a bone-stock powder. After emulsification the concentrated stock can be spray dried or roller dried. Carriers may be added to minimise the clumping effect of fat and to maintain a free-flow powder. After drying to around 5% moisture content, the material is milled and screened to an appropriate size.

As bone-stock powders will be resuspended for further use, their specifications generally call for small particle sizes. Consequently, screening through as fine a screen as 120 mesh may be necessary. This is only achievable with low-fat powders. High-fat products are normally prepared as concentrated extracts.

The powder is packed in plastic-lined multi-wall bags or in bulk food-grade units as required.

Processing equipment

As the bone-stock extraction process has long cook times, a batch process is required. The equipment used is simple, readily available and similar to that used in a low-temperature rendering process but constructed and operated to edible standards. The major items of equipment are the mincer, for size reduction; and the centrifugal separator, for fat separation. Both items are available manufactured from food-grade materials.

For concentration to a bone-stock extract, or for drying to a powder, considerable capital is required for a multiple effect evaporator and evaporation pans or drier. Estimated budget costs for equipment capable of evaporating 750 kilograms of water per hour are:

- multiple effect evaporator $150,000
- evaporation pans $50,000

Water evaporation at 750 kilograms per hour would handle a process throughput of some 600 kilograms of bones per hour.

Yield from 600 kilograms of bones is dependent on the raw material used, but would be expected to be around 55% based on 75% recovery of the available protein in the raw bone. A process capable of handling 600 kilograms of bone per hour would produce some 340 kilograms of extract to the typical composition given above. A minimum of around 4–5% free fat would be recovered from a gravity-settling process. This would be expected to be considerably higher with a low-fat extract from a process using a centrifugal separation step.

Production of a chilled ready-to-use bone-stock liquor, without concentration, and using a gravity-settling process, would be an inexpensive and less complex way to enter the bone-stock market.

Further reading

Further information on this topic is available from the following project funded by the Meat Research Corporation:

- Project STR.008: Co-products Development.

Further detail is available from the final project report for this project which is available from Meat and Livestock Australia.

Related information is given in these MLA Co-products brochures:

- Edible meat powders and extracts
- Stickwater recovery.

Contact

Processing & Product Innovation

Meat and Livestock Australia

Tel: (02) 9463 9166 Fax: (02) 9463 9182

MEAT & LIVESTOCK AUSTRALIA

165 Walker Street, North Sydney NSW 2060

Tel: (02) 9463 9333 Fax: (02) 9463 9393 www.mla.com.au

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