



The use of enzymes in yeast processing

- Accelerated process
- Higher yields
- Reduced viscosity
- Improved solubilization of debris
- Clarification of extract
- Compensates for damaged/killed cells
- Improved flavour

BACKGROUND

Yeast extract is well known for its use as a food flavouring in many food products, e.g. soups, sauces, gravies, snack foods, and meat products. It is the main component of savoury spreads such as Vegemite® and Marmite®. Yeast extract is produced by hydrolysing bakers' yeast or spent brewers' yeast to provide a paste with a very strong savoury flavour. It is essentially a concentrate of the soluble cellular components of the yeast (such as amino acids, nucleotides, peptides, proteins, sugars, vitamins and flavour compounds) and is an excellent source of protein, B vitamins and nucleotides. The constituents from different *Saccharomyces* yeasts are usually similar. Bakers' yeast tends to have a higher carbohydrate and lower protein level than brewers' yeast.

An essential part of yeast processing is the break down of the cell wall. The yeast cells can be disrupted using mechanical methods or 'burst' when suspended in water. Once some of the cells have been disrupted, endogenous enzymes released from within the yeast start to hydrolyse the cell content by autolysis. Exogenous enzymes are added to accelerate this process resulting in decreased processing times and higher yields. The autolysis process is normally terminated when the alpha-amino nitrogen exceeds 50%.

Enzymes are also an effective way of breaking down the yeast cell wall. The characteristic components of yeast are chitin (beta-1,4-linked homopolymers of n-acetylglucosamine in microcrystalline state) and glucans (primarily alpha-glucans with alpha-1,3-and alpha-1,6- linkages). Although these are the bricks and mortar of the cell wall other important components such as mannans, glycoproteins and lipids are also present. In addition to aiding cell wall digestion, the addition of enzymes can be used to improve the flavour of the end product.

BIOCATALYSTS RANGE OF ENZYMES FOR YEAST PROCESSING

PRODUCT	BENEFIT
Promod™ 144P	Promod™ 144P is a general purpose protease from a plant source ideal for aiding the release of cellular components from yeast. Addition of Promod™ 144P prior to plasmolysis can accelerate the yeast lysis process and result in increased release of savoury flavour compounds and other valuable cellular components
Depol™ 667P	Depol™ 667P has been specially formulated to help degrade glucans in the yeast cell walls reducing viscosity and improving solubilization and clarification of the extract and increasing yield of solubles
Promod™ 192P	Promod™ 192P is a peptidase preparation from a fungal source with low levels of endo-protease. It is useful in debittering protein hydrolysates. Flavorpro 192P can be added to heat damaged or killed yeast to compensate for the destruction of endogenous enzymes which would otherwise result in poor autolysis



YEAST EXTRACT PRODUCTION PROCESS OUTLINE

Although the details of the production process might vary from manufacturer to manufacturer, with regard to temperature, pH or the duration of each step, most follow the general pattern of 'plasmolysis, autolysis, pasteurisation, clarification and extract concentration'. As an example, typical conditions for preparing an extract of a Baker's type yeast are outlined on the right:

PROCESS CONDITIONS FOR YEAST EXTRACT PRODUCTION

1. Dilute yeast cream to 600g/l (28% dry weight) and adjust pH of yeast cream to about 5.
2. Promod 144P at 400g and sodium chloride at 3.5 kg per 1000 litres. (containing 600 kg of yeast cream). Raise temperatures over 5-8 hours to 55°C.
3. Hold at 55°C for 24 hours (plasmolysis - Step 1 and autolysis - Step 2).
4. Raise temperature to about 70°C and hold for 15 hours (completes autolysis and starts pasteurisation - Step 3).
5. Centrifuge to remove cell debris. Counter current washing for maximum yield of extract (Step 4).
6. Heat the extract to 70-75°C for 2-5 hours (completes pasteurisation). If evaporator capacity is limiting, extract may be held at this temperature for longer.
7. First evaporation under partial vacuum to above 30 per cent solids (Step 5).
8. Polish filtration to remove any precipitate during concentration 1.
9. Second evaporation to 70-75 per cent solids using vacuum. Ensure temperature does not exceed 55°C

Note: Variations in the temperatures, holding times, pH, proteases and the level of salt used will affect yield and flavour.

STEP 1: PLASMOLYSIS:

A simple method for the initiation of cell disruption. Favourable conditions include raised temperature - sufficient to kill the yeast but not to inactivate its enzymes and the addition of chemicals, in particular salt or organic solvents such as isopropanol.

These added plasmolysing agents, because they have some bacteriostatic or bactericidal effect, perform the additional role of reducing the growth of any contaminating bacteria which can cause a high viscosity in the extract, hamper clarification and impair the flavour of the final product.

Salt, as a condiment, contributes to the flavour. However, if the extract is made by heat alone (or with an organic plasmolysing agent), it will be more bland but will be low in salt, making it suitable for use in special applications eg food for convalescents, infant and baby foods.

Suitable conditions for a temperature-alone plasmolysis are pH 5.5 and 40 - 48 hours at 58°C, to achieve yields of around 65 per cent. Similar results are obtained if isopropanol is used at 0.5 per cent v/v, but with a lower temperature for the first 5 hours.

STEP 2: AUTOLYSIS:

Self-digestion of the yeast cell contents. During this stage, the enzyme-catalysed hydrolysis is achieved commercially by relying on the yeast's own enzymes, possibly augmenting them with an added protease such as Promod™ 144P (P144P) at about 0.04 per cent w/w of the yeast cream.

The added P144P is useful for increasing solubilization in long autolysis processes only. Using the process outlined in Table 1, the presence of P144P increases the final yield by only about five per cent, and this is only detected relatively late in the autolysis.

Short autolysis times do not give maximum yield of extract when relying on the yeast's own proteases, but under such conditions the addition of P144P also does not increase the yield. Higher levels of P144P do not produce improvements.

STEP 3: PASTEURISATION:

This serves to kill vegetative cells of bacteria, and the temperature used is sufficiently high to inactivate P144P and yeast proteases.

In the process typified by Table 1, no further solubilization occurs during the pasteurisation, but interaction of small molecules in particular amino acids and sugars, leads to flavour development.

STEP 4: CLARIFICATION:

Clarification removes insoluble cell wall debris, glucans, mannans and some protein which, despite the presence of mannanases and glucanases in the yeast, is only slightly degraded during autolysis.

Some solubilization of this debris can be achieved with a glucanase preparation such as Depol 667P used during the autolysis stage. Insoluble material is discarded as waste or can be incorporated into animal feed, or may find use as a flavour carrier.

A second clarification step may follow the first concentration to produce a clear extract by removing the haze formed during concentration. This haze is partly composed of less soluble oligopeptides precipitated at the concentration stage.

STEP 5: CONCENTRATION:

This is usually in two stages, with a final filtration interposed. During the extraction concentration, further development of flavour occurs, influenced by the increasing concentration of the components and by the temperature.

To avoid the development of burnt flavours during the final evaporation, a temperature not exceeding 55°C is achieved by the application of vacuum techniques.

Note: Heat denatured yeast. Many breweries now operate an alcohol recovery programme from the waste yeast.

This process involves heat which kills a lot of the yeast and inactivates many of the yeast's own enzymes required for autolysis. In this case, additional protease/peptidase is required over and above P144P.

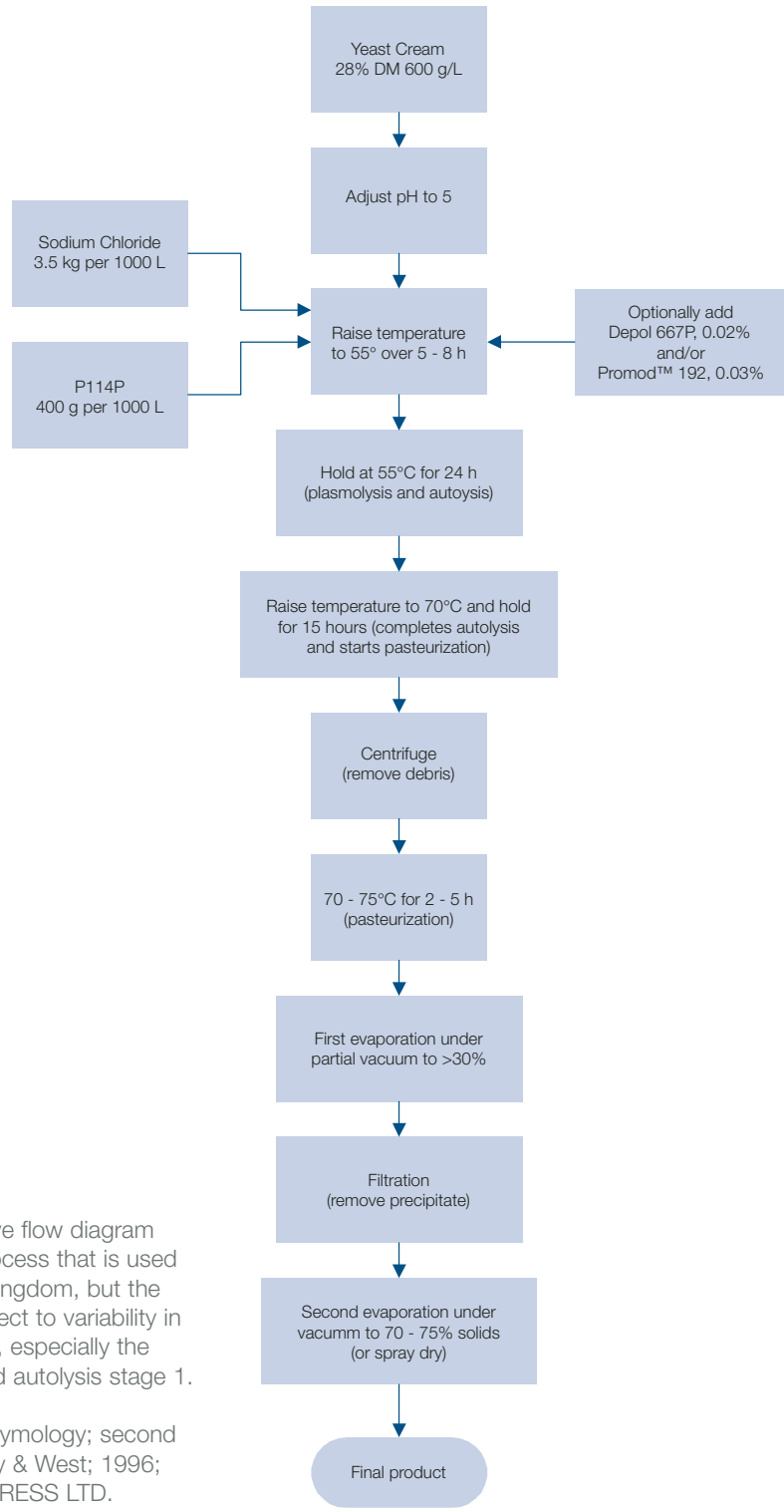
Our peptidase product Flavorpro 192P can be used to compensate for the partial destruction of the endogenous enzymes when used at a dose rate of 0.01 to 0.03% w/w of the yeast cream.

COMMON PROBLEMS ENCOUNTERED IN YEAST EXTRACT PRODUCTION

PROBLEM	SOLUTION
Enzyme not working	Ensure no direct heat is de-naturing enzyme solution and rendering it ineffective.
Low yield following autolysis	<ul style="list-style-type: none"> • Check pH and temperature of slurry at each stage • Extend autolysis time • Increase dose of P144P
Heat (e.g. during alcohol recovery stage) inactivates yeast proteases, preventing efficient autolysis	Add Flavorpro 192P, 0.01 – 0.03% w/w yeast
Clarification problems caused by insoluble glucans	Add Depol 667P, 0.02% w/w yeast
Evaporator capacity limiting	Extend pasteurisation time
Burnt flavours	Keep temperature below 55°C during final evaporation stage



FLOW DIAGRAM of Yeast Extract production



Note: The above flow diagram outlines the process that is used in the United Kingdom, but the process is subject to variability in other countries, especially the plasmolysis and autolysis stage 1.

1 Industrial Enzymology; second edition; Godfrey & West; 1996; MACMILLAN PRESS LTD.

