1 Production of Bread, Cheese and Meat

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I. Introduction

Historic references to fermentation of dough for baking and fermentation of beer originate from the Sumerians and the Babylonians and, under the Pharaohs in ancient Egypt, the brewing of beer was a trade (Jorgensen 1948). At that time, the fermentation of bread was achieved by using a mixture of yeast and lactic acid bacteria maintained in a dough medium. After each fermentation, a portion of the dough was retained for starting the next batch or a close connection with beer brewing was established so that surplus yeast from breweries was used for production of bread. These same methods are still used in certain regions in Africa and probably other parts of the world where ancient technologies have survived and can be experienced today. In the industrialised part of the world, these methods remained in use, and did not change until late in the eighteenth century when yeast was first propagated for direct use in bread making in the Netherlands by the so-called Dutch method, which had a very low efficiency. As a result of the work of Louis Pasteur and the Danish botanists, Emil Christian Hansen and Alfred Jorgensen and others in the late nineteenth century, the role of oxygen in yeast propagation was realised, the anaerobic condition of fermentation (“life without oxygen”) was understood,Saccharomyces cerevisiae was described and the use of pure cultures was introduced. This was a very significant breakthrough for the industrial production of baker’s yeast. A similar process improvement followed in 1920, with the introduction of the “fed-batch” process. In this process, sugar is fed incrementally during yeast propagation, avoiding repressions and leading to increased biomass production. It forms the basis of commercial processes used today for manufacturing baker’s yeast, and has developed into a highly centralised industry offering a cheap bulk commodity. This is contrary to the historical development of other industrial yeast cultures like brewer’s yeast (Jorgensen 1948). For reviews on the history of baker’s yeast, see Rose and Vijayalakshmi (1993) and Jenson (1998).

In cheese, the role of yeast is not yet fully understood, but the yeast seems to take part in several microbial interactions important for the fermentation and maturation process of several cheeses (Jakobsen and Narhhus 1995). The species of particular interest are Debaryomyces hansenii, Yarrowia lipolytica and Galactomyces geothricum, according to present taxonomic descriptions (Kurtzman and Fell 1998). However, for the mycelial fungi, the use of Penicillium roqueforti and Penicillium camemberti has a long history in cheese production. According to early records,
names of blue and white mould cheeses are dated
to year 879 for Gorgonzola, 1070 for Roquefort,
1785 for Stilton and 1791 for Camembert
(Robinson 1995). These cultures are important
starter cultures, which are commercially available
and widely used by the dairy industry. Their tech­
nological properties have been studied over a
number of years and, although not fully under­
stood, useful information has been collected as
reviewed by Gripon (1993).

Compared with bread and cheese, meat is the
least developed area concerning the use of yeast
and mycelial fungi as starter cultures. Apart from
a few examples of using Penicillium nalgiovense
for surface ripening of sausages and D. hansenii
for fermentation of sausages and other meat
products, limited information is available. The role
of micro-organisms is unclear, but bacteria rather
than fungi appear to be responsible for flavour
development in fermented meat (Montel et al.
1998). However, several important meat products
like Parma and Serano ham are still spontaneously
fermented and the possible role of yeasts and
mycelial fungi has not been studied in detail.
An increasing interest is seen in research work
leading to the understanding of the role of micro­
organisms in traditional spontaneously fermented
meat products including the significance of yeast
and mycelial fungi. For a review on fungal ripening
of meat, see Cook (1995) and Lücke (1998).

II. Bread

A. Baker’s Yeast

Yeast-fermented breads in Europe and the United
States are mostly based on wheat, although rye is
commonly used for some popular bread types in
Scandinavia and other northern European coun­
tries. A large variety of breads is produced, and
the European tradition for consumption of bread
seems to spread over the world, including regions
like South-East Asia and Africa, as a result of the
strong impact of European eating habits. Traditional
bread making in Africa does not seem to be
widely known, but strong traditions exist for fer­
m entation of cereals, with yeast playing a signifi­
cant role, especially in co-cultures with lactic acid
bacteria, as was also the case in the past in Europe.
For Sudan, 11 types of sorghum and millet bread
are described by Dirar (1993) and in other parts
of Africa various cereal dough fermentations, like
kenkey made from fermented maize dough in
Ghana (Halm et al. 1993), play a substantial role
in the daily food intake.

In all cases, the dominant yeast appears to be S. cerevisiae Meyen ex E.C. Hansen with the
taxonomic delimitation given by Vaughan-Martini
and Martini (1998). It is considered the principal
species responsible for cereal fermentation and
bread making as well as alcoholic fermentations,
except for fermentation of lager beer.

The current taxonomy within the genus Saccharomyces is complex and apparently not
fully understood (Jespersen et al. 1999; Hayford
and Jespersen 1999). It means that S. cerevisiae as
baker’s yeast still has to be defined by pheno- and
genotyping as well as technological properties in
relation to bread making.

Several methods based on molecular tech­
niques have been reported for subspecies typing
of Saccharomyces spp., one of the most popular
methods has been determination of chromosome
length polymorphism, e.g. by pulse field gel elec­
trophoresis (PFGE) as shown in Fig. 1 for nine
strains of S. cerevisiae isolates from spontaneously
fermented maize dough in Ghana. As chromo­
some length polymorphism is evident among the
isolates, the technique clearly shows that several
subspecies are involved in the fermentation
process. Further, the observed chromosome pro­
files are quite similar to chromosome profiles
observed for baker’s yeast. According to general
experience and recent studies (Gasent-Ramirez et

![Fig.1. Chromosome length polymorphism determined by pulse field gel electrophoresis (PFGE) of nine different Saccharomyces cerevisiae isolates from spontaneously fermented maize dough in Ghana. Lanes 1, 7 and 12 are markers](image-url)