

SYMPOSIUM ON MICROBIALY INDUCED FLAVORS AND FERMENTED FOODS

Introduction

As an introduction to this Symposium it is appropriate to reflect that microbially induced flavors and fermented foods played a most significant role in the founding of the science of microbiology.

The commercial value of wine led the great chemist and experimentalist, Louis Pasteur, to discover the fermentative powers of yeast and bacteria. He was the first to demonstrate that certain microorganisms are economically significant because of their ability to produce flavor compounds. He was the first to demonstrate that flavor of a fermented beverage could be improved and controlled by a heat process, which bears his name, because he understood the powers and properties of both desirable and undesirable microorganisms.

Today we can more completely appreciate the powers of a great many microorganisms, but we are still quite unable to explain many of the things they can do. We are indebted to Pasteur for launching the study of their activities, but we are indebted to microorganisms for continuing to give us a variety of many wonderfully flavored foods and beverages such as yogurt, cheese, bread, wine, beer, etc.

The chemical changes induced by microorganisms in these foods are varied and complex. Most are a result of the organism's attempt to sustain life in the food, but some occur after the organism's death, when its intra-cellular enzymes are released for activity. In

many instances, it is not possible to duplicate a microbially induced flavor because more research is needed to identify the chemical constituents elaborated by microorganisms and their enzymes. Moreover, some of the already identified flavoring constituents can only be produced economically by a microbial process. Thus, the production of the L-isomer of glutamate and of the 5'-nucleotides relies almost completely on microorganisms for commercial production. Other complex flavoring materials will undoubtedly have to await biosynthetic or controlled biodegradative methods before becoming commercially available.

In organizing this Symposium, an attempt was made to encompass most of the important foods in which microbially induced flavors occur. Unfortunately, the subject of vegetable fermentations such as pickles, sauerkraut, and olives is omitted, but I am pleased by the representation in the areas of dairy, sausage, fish, bread, and oriental food products.

I trust that the Symposium will inspire interest and research toward an improved understanding of flavor production by microorganisms and their enzymes.

E. W. SEITZ
Flavor Research Department
International Flavors and Fragrances
Union Beach, N.J. 07735

Microbially Induced Flavors and Fermented Foods

Flavor in Fermented Dairy Products

William E. Sandine and Paul R. Elliker

Compounds believed involved in flavor and aroma of nonripened fermented dairy products include lactic and acetic acids, acetaldehyde, formic acid, ethanol, carbon dioxide, diacetyl, dimethyl sulfide and other sulfur compounds, methyl ketones, primary and secondary alcohols, methyl, and ethyl esters of aliphatic acids and lactones. Homo-fermentative lactic streptococci (*Streptococcus lactis* and *Streptococcus cremoris*) ferment milk lactose by the hexose diphosphate pathway to produce lactic acid with small amounts of the other products.

Heterofermentative streptococci (*Streptococcus diacetilactis* and *Leuconostoc citrovorum*) use the hexose monophosphate pathway producing less acid and more of the other end products, depending on aeration; they also ferment citric acid, producing diacetyl via both α -acetolactate and acetyl CoA. Over 100 compounds have been identified in the volatile fraction of Cheddar cheese; those believed important include acetic, butyric, caproic, and caprylic acids, hydrogen sulfide, glutamic acid, methional, and carbonyl compounds.

The capacity of microorganisms to convert the carbohydrates, proteins, and fats occurring naturally in foods to a large number of different chemical compounds allows man to introduce great variety into his eating and drinking experience. Cheese alone provides well over

1000 products, each different as a consequence of controlling the environment of the ripening curd such that certain organisms are favored in growth to flavor the finished product. This paper will be concerned with flavor in fermented dairy foods and three products have been selected—yogurt and cultured buttermilk as examples of nonripened fermented foods, and Cheddar cheese as an example of a ripened dairy product. Compounds believed to be important in the flavor

Department of Microbiology, Oregon State University, Corvallis, Ore. 97331