CHAPTER 1

INTRODUCTION
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Worldwide there are more overweight and obese people (1 billion) than there are malnourished human beings (0.8 billion). Today the challenge lies not just in meeting basic nutritional needs, but providing additional protective ingredients to help preventions of the major chronic diseases associated with obesity. Biotechnology has become an important tool in recent years and scientists are now investigating advanced and novel strategies for the improvement of the functional aspects of food and food ingredients in an effort to manage the current and emerging health care challenges.

NUTRACEUTICAL AND FUNCTIONAL FOOD

The term "nutraceutical" was coined from "nutrition" and "pharmaceutical" in 2002 by Stephen L. DeFelice, MD, founder and chairman of the Foundation for Innovation in Medicine (FIM), Cranford, NJ. According to DeFelice, a nutraceutical can be defined as, "a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease." When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food." Thus, functional food provides the body with the required amounts of vitamins, fats, proteins, carbohydrates, and minerals needed for its healthy survival. When a functional food aids in the prevention and/or treatment of disease(s) and/or disorder(s) (except anemia), it is called as nutraceutical (DeFelice, 2002; Kalra, 2003).

Fermented Functional Food

Biotechnology has been described as the application of scientific and engineering principles to the processing of materials for the provision of goods and services through the use of biological systems and agents. In a very real sense, biotechnology originated with traditional food fermentations in developing countries. Over the generations, this
pioneering practice has been expanded and improved so that microorganisms and other biological agents have found use in many other areas. Recent developments in genetics, enzymology, recombinant technology, and fermentation technology have led to advances in biotechnology far beyond the original traditional scope (Hesseltine, 1965; Parvez et al., 2006).

Fermented foods are food substrates that are invaded or overgrown by edible microorganisms whose enzymes, particularly amylases, proteases and lipases hydrolyze the polysaccharides, proteins and lipids to nontoxic products with flavors, aromas and textures, which are pleasant and attractive to the human consumer (Steinkraus, 2002).

Fermentation plays at least five roles in food processing (Steinkraus, 2002):

i. Enrichment of the human dietary through development of a wide diversity of flavors, aromas and textures in food.

ii. Preservation of substantial amounts of food through lactic acid, alcoholic, acetic acid, alkaline fermentations and high salt fermentations.

iii. Enrichment of food substrates biologically with vitamins, protein, essential amino acids, essential fatty acids and with secondary metabolites of microorganisms.

iv. Detoxification of toxins during food fermentation processing.

v. Decrease in cooking times and fuel requirements.

For fermented products like cheese, bread, beer and wine, scientific and technological knowledge of the processes is well developed. However, for traditional fermented products, this knowledge is poor. Many indigenous fermented foods are produced by spontaneous or natural fermentation, but specific microorganisms predominate. Isolation and characterization of predominant organisms is essential. Information should be collected on all traditional fermented foods and it must be thorough. No food should be excluded thinking it is not important or well known. A thorough microbiological, nutritional, and technical investigation should be carried out on each of the processes (Steinkraus, 1994; 1997). The various microorganisms involved in each fermentation should be isolated, characterized, studied, and preserved. The biotechnological worth of
each organism should be determined. Isolation should not be confined to the dominant organisms because other microbes found in lower numbers might have an important function in the process. The role of each organism should be identified. Much basic research is needed to determine the scientific and technological factors in the preparation of these traditional products (Hesseltine and Wang, 1980). Since the participating microorganisms largely control the qualities of fermented foods, understanding their role is vital.

In food fermentations, raw materials are converted to products through the use of biocatalysts. Each member of this equation is important. For widely used plant substrates, for example, breeding to reduce toxic or antinutritional components or to increase protein or vitamin content, this process would be useful. Alternatively or additionally, it would be valuable to identify microorganisms that can synthesize important ingredients (e.g., essential amino acids, vitamins) for populations where malnutrition is a problem. Some additional desirable traits for these microorganisms are: an ability to produce flavor components which favor consumption of these foods in traditional and new markets; the capability to break down anti nutritional factors (i.e., phytic acid) present in some substrates; the production of enzymes to utilize recalcitrant wastes as substrates; the inability to synthesize toxins and other undesirable secondary products; and thermo tolerance and osmo tolerance, which are important characteristics in solid substrate fermentation processes (Hesseltine and Wang, 1980). In many parts of the world, fermented foods form an important part of the diet. These foods are made from plant and animal materials in which bacteria, yeasts, and molds play an important role by modifying the material physically, nutritionally, and organoleptically.

Food fermentations can be classified in a number of ways:

By categories (Yokotsuka, 1982):

i. Alcoholic beverages fermented by yeasts; for example Palm and Jackfruit wines in India, Indian rice beer.
ii. Vinegars fermented with *Acetobacter*; for example palm wine vinegars in Africa and the Far East, coconut water vinegar in the Philippines; *Kombucha* in Europe, Indonesia, and in Japan.

iii. Milks fermented with *lactobacilli*; for example yogurts in the western world, Russian *kefir*, Middle-East yogurts, *liban* in Iraq, Indian *dahi*, Egyptian *laban rayab*, *laban zeer*.


v. Fish or meat fermented with *lactobacilli*; for example *Burong-isda* from Philippines, *Nem-chua* from Vietnam

vi. Plant proteins fermented with molds with or without *lactobacilli* and yeasts; for example *pozol* (Mexico), *kenkey*, *ogi*, and *injera* (Africa), *angkak* (China).

By classes (Campbell-Platt, 1987)

i. Beverages; for example sugarcane wines, palm wines, Japanese sake, Indonesian tape, Malaysian *tapuy*, Chinese *lao-chao*, Thai rice wine, Indonesian *brem*, Philippine *tapuy*.

ii. Cereal products; for example Mexican *pozol*, Ghanaian *kenkey*, Philippine *balao balao*, *burong dalag*; *injera* (Africa); *angkak* (China).

iii. Dairy products; for example yogurts in the Western world, Russian *kefir*, Middle-East yogurts, *liban* in Iraq, Indian *dahi*, Egyptian *laban rayab*, *laban zeer*.

iv. Fish products; for example *Burong-isda* from Philippines, *Sukua* from India

v. Fruit and vegetable products; for example *sauerkraut*, cucumber pickles, olives in the western world; Egyptian pickled vegetables, Indian pickled vegetables and Korean *kim-chi*, Thai *pak-sian-dong*, Chinese *hum-choy*, Malaysian pickled vegetables and Malaysian *tempoyak*.

vi. Legumes; for example Indian *idli*, *dhokla*, *khaman*, Sri-lankan *hoppers*; Sudanese *kisra*, *ontjom* (Indonesia) and *dawadawa* (Savannah Africa);

vii. Meat products; for example Thai *nham* (fermented fresh pork). *Nem-chua* from Vietnam
By commodity (Odunfa, 1988)

i. Fermented starchy roots, such as gari (Africa) and farinha puba (Brazil, Peru, and Ecuador)

ii. Fermented cereals, such as pozol (Mexico), kenkey, ogi, and injera (Africa), angkak (China)

iii. Alcoholic beverages, such as sugar cane wines, palm wines, Japanese sake, Indonesian tape, Malaysian tapuy, Chinese lao-chao, Thai rice wine, Indonesian brem, Philippine tapuy.

iv. Fermented vegetable proteins, such as ontjom (Indonesia), dawadawa (Savannah Africa), Indian pickled vegetables and Korean kim-chi, Thai pak-sian-dong, Chinese hum-choy, Malaysian pickled vegetables and Malaysian tempoyak.

v. Fermented animal protein, such as Thai nham (fermented fresh pork). Nem-chua from Vietnam.

Most traditional fermented plant foods are prepared by processes of solid substrate fermentation in which the substrate is allowed to ferment either spontaneously (usually African or Latin American processes) or by adding a microbial inoculum (Far East, South Asia, and Southeast Asia) (Beuchat, 1998; Knechtges, 2002).

Fermented plant foods may be classified into groups as

i. Made from cereal grains (maize, sorghum, millet, rice, wheat), such as pozol (Mexico), kenkey, ogi, and injera (Africa), angkak (China).

ii. Made from pulses, nuts, and other seeds, such as ontjom (Indonesia) and dawadawa (Savannah Africa).

iii. Made from tubers (cassava, aroids, potatoes), such as gari (Africa) and farinha puba (Brazil, Peru, and Ecuador).

iv. Made from fruits and vegetables, such as gundruk (Nepal) and kimchi (Korea, East Asia).

v. Beverages derived from tree saps, such as nipa wine (Far East) and pulque (Mexico).
ANGKAK (Chinese Fermented rice)

Angkak, red fermented rice (RFR) or red rice also known as in Chinese as Hung-ch'u or Hongqu, red yeast rice, red koji or anka, is an Asian traditional fermentation food source (Sung, 1966; Hu, 1997). It is coming under the category of nutraceutical produced by fermentation. RFR is a kind of fermentation product of steamed rice by a food fungus, called Monascus genus, which van Tieghem in 1884 firstly screened from angkak. In China, it is extensively used in foods and folk medicine, and prior to the Zhou Dynasty (770–221 BC), the documentation recommended the use of angkak for colorants of cooking and in Chinese traditional medicine.

Angkak is known mostly for its use in food as a preservative and colorant, and its uses in the dye industry and used for hundreds of years in China in rice wine making, fermentation starters to brew red wine, primitive beer and alcoholic drinks (Sung, 1966; Chen, 1982; 1987; Hu, 1997) and as a food preservative. In addition, angkak has been known as an ancient Chinese medicine or an ingredient in certain ancient Chinese prescriptions.

Up to now, a lot of work has been done on angkak research and production. For example, angkak, which has been traditionally used as a colorant in oriental foods, has been rediscovered for natural colorants by modern food industries (Hu, 1982; Blanc et al., 1994), and is authorized for food use in China and Japan (Blanc et al., 1994). Angkak, which has long been recognized as a folk medicine for improving food digestion and blood circulation in China, has been consumed as a nutraceutical through out the world (Sung, 1966; Chen, 1982; Hu, 1997; Wang et al., 1999), since it contains functional material, such as monacolin K, commercially known as Mevacor, Cholestín and Lovastatin, which may maintain a healthy blood lipid level by decreasing body’s production of cholesterol (Endo, 1979; Bach, 1986; Wang et al., 1997, Li et al., 1998; Kennedy et al., 1999; Heber et al., 2001).

Modernly, angkak, the fermentation product of Monascus species, is still used in traditional Chinese medicine, wine making and food coloring in Asia and Asian
communities in North America. The red and yellow pigments of *Monascus purpureus*, such as monascorubin and monascin, have been purified and extensively studied. The culture condition and its effect on pigmentation of *Monascus purpureus* have also been investigated (Broder *et al.*, 1980). Antibacterial activity, especially against *Bacillus* species, was also detected in *Monascus purpureus* extract (Wong and Bau, 1977). The angkak produced by traditional methods has been shown to be of little value and thus has gradually fallen out of use in medical applications due to its little effect on reducing blood lipids, and thus has never been used as a cholesterol-lowering agent.

Angkak has empirically recognized as safe in Asia for centuries (Chen and Hu, 2005). However, during the past 10 years, some researchers have discovered and demonstrated that some strains of *Monascus* could produce citrinin, a nephrotoxin, which was previously found mainly in *Aspergillus* and *Penicillium* genera (Wang *et al.*, 2004), and might contaminate angkak (Blanc *et al.*, 1995; Hajjaj *et al.*, 1999; Sabater-Vilar *et al.*, 1999; Heber *et al.*, 2001). This triggered a controversy about the safety of angkak. Although recent research has confirmed that angkak implies no threat to health at all (Chen and Hu, 2005; Allok, 2004), most researchers consider that some actions should be taken to control citrinin concentration in angkak (Mandt, 1998; Hu and Chen, 2003). In Japan, the maximum allowed level of citrinin in angkak is authorized to be 200 ng/g. In China and the European Economic Community, the similar citrinin level in angkak is still under debate (Mandt, 1998). So, to avoid citrinin-contaminating angkak, or to keep citrinin concentration low, new method of solid-state fermentation for production of high quality angkak having maximum quantity of monacolin K (Lovastatin) and low quantity of citrinin was necessary.
REFERENCES


