EXPLOITING GRASS-ROOTS FOOD TECHNOLOGY IN DEVELOPING COUNTRIES

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Major food technology advances generally start in developed countries and find gradual application in the developing world. However, application of such advances nearly always requires a large capital investment which can be justified only in the presence of a mass consumer market. This generally limits the application of these advances to urban areas and to products for those consumers of better income living in a money economy. An example of such technology is that which has resulted in textured vegetable protein foods. This development from the United States has proved of great interest to numerous developing countries and is beginning to achieve some application in these countries.

In the villages, however, where people live in a subsistence economy, such advanced food technology can only have a marginal effect because money is lacking to purchase the more sophisticated foods. And, a concentrated mass market does not exist. Thus, there is no warrant for the capital investment and effort needed to market such foods. Yet, the existence of malnutrition and undernutrition is widespread in the rural areas.

To meet these urgent needs, a grass-roots science of applied nutrition and food technology is needed. This grass-roots science should:

1. Identify and fully characterize useful native food ingredients, especially those rich in protein;
2. Provide simple technology for the removal of toxic, inedible, and ill-tasting components from such native crops;
3. Prepare good foods by formulating readily made blends of culturally accepted foods (corn, rice, and cassava for example) with useful native supplementary food ingredients;
4. Create recipes that will fit the improved foods or food blends into the current eating patterns of the people;
5. Provide simplified nutrition education to motivate village people to prepare and use the improved foods.

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What is Grass-Roots Food Technology?

Fish Concentrate

The contrast between sophisticated food technology and the grass-roots variety can be exemplified by comparing the production of fish protein concentrate with the production of a salted fish block.

In the former, the fish is subjected to a highly sophisticated solvent extraction process requiring a considerable investment in plant equipment. And although the resultant product has a long shelf life, it is essentially a new food ingredient requiring extensive consumer education and motivation for acceptance.

In the case of the fish block (del Valle, 1972), the fish flesh is minced and simultaneously salted and compressed into a block. The block is then sun dried. Presumably, enough of the original texture and flavor of the fish is thus retained so that a major consumer motivation effort will not be needed (consumer tests have so far been satisfactory). The useful shelf life of such a salted block is no doubt shorter than that of fish protein concentrate. Yet it is long enough to permit supplying fish for a considerable distance inland from the sea. The developers of this process believe that a small operating plant could be managed by virtually one family with a very modest capital investment.

Soybean-Banana Blend

Another interesting example of grass-roots food technology has been that applied to making a soybean-banana blend (Steinberg, 1972). "Drop dry soybeans into boiling water and simmer for 30 minutes, drain, and discard water. Rinse the soybeans in tap water to cool. Mash the beans (as in a hand meat grinder). Mash the bananas in the presence of a little citrus fruit juice (such as lemon or lime). Mix the banana and soy pulps together. Let stand for a few minutes and then eat."

This blend could no doubt be made supplementing the bananas with one of many other native legumes or oilseeds besides soybeans (if these are not available). The banana supplies good flavor, minerals, trace elements, vitamins, and readily digestible carbohydrates. The legume or oilseed supplies primarily protein and oil. The combination would seem to be a happy one for such purposes as weaning and children's foods, and, in general, as a very acceptable well-balanced low-cost food.

Besides the very elementary procedure described Steinberg (1971) has also described a pilot plant process for making a weaning food which is closely related to the soybean-banana blend just described: Whole soybeans are simultaneously hydrated and blanched for 30 minutes in boiling water. Ten parts water are added to one part blanched beans. The beans are then finely ground in a comminuting mill. Fresh ripe bananas are added at a ratio of one part banana solids to one part soybean solids and blended in the same mill in the presence of 100 ppm of sodium bisulfide to prevent darkening. The slurry is dehydrated to the present moisture using a double-drum drier with 0.01 in drum spacing and 40 psig steam pressure in the drums. The resulting product has a pleasant flavor and is readily reconstituted with water. It has a very acceptable shelf life. Other native fruits could be used in place of the banana and other native legumes or oilseeds in place of the soybeans.

The process just described would require a substantial investment for the comminuting mill and the drum drier. However, one can visualize a process using thermal extrusion equipment, such as is used in producing textured vegetable protein, but of possibly a less-sophisticated character. I have dwelt on this example because it does indicate several levels of food technology sophistication and does make use of indigenous ingredients.

Bread-Making

Another example of applied food technology which can range from the grass roots to a more sophisticated type is the production of baked goods of enhanced nutritional value. It has been long known that wheat flour (the mainstay of break-making) contains an incomplete protein. With the development of new bread improvers such as sodium stearoyl lactylate or the sucrose fatty esters, it is possible to make acceptable bread of improved nutrition by adding substantial increments of legume or oilseed flours to the wheat flour, or by adding nutritionally valuable by-products such as rice polish. Even when the bread is baked in relatively primitive ovens using rudimentary dough-making equipment, acceptable bread can be made closely resembling in appearance the unfortified bread that the available equipment produces. Relatively minute percentages of the bread improvers are required and these can be imported from the USA or Europe.

Another procedure consists of adding intact bits of a high-protein food such as fish, poultry, meat, legumes, oilseeds, or textured vegetable protein to a dough before baking (Bacigalupo, 1972). This causes a minimum change in the desired structure of the baked goods. At the same time, there is enhancement of the protein content.

Preservation Methods

Simple methods of preservation to extend the shelf life of foods are in ever-present need in developing countries. One such method, osmotic dehydration (Hope and Vitale, 1972) is applied to mangoes, plantains, and bananas. In this process a 67% sugar solution is prepared in unheated water. Ripe bananas or plantains are cross-cut into 2-4 cm thick segments and placed in four times their weight of this sugar solution and held for 18 hours with occassional gentle mixing. Next, the slices are transferred to a 60% sugar solution containing one percent SO_2 supplied from potassium metabisulfite and held for one hour. The slices are then removed and drained thoroughly. They are then given a brief dip (one minute) in clear cold water to reduce stickiness.

The partially dehydrated slices (if extended storage is needed) can now be sun- or even shade-dried. A cabinet drier (if available) will accelerate the drying which can be safely completed in about 18 hours at 48°C, 50% relative humidity and with a linear air flow of 300 meters/minute. One can visualize an array of tropical fruit confections made by variations of this osmotic dehydration process.

Marmalade

Interesting marmalades can also be made by boiling down a citrus juice made from oranges, lemons, or limes to which sugar has been added and then adding thin slices of ripe banana at the later stages of cooking. The acidity of the juice completely preserves the light color of the banana slices and the slices contribute an appealing flavor and appearance.

Fermentation Technology Offers Promise

Fermentation technology lends itself with great flexibility to producing foods of extended shelf life having excellent flavor and nutritive value. Such technology can be applied in the home, at the village level, or in full-scale commercial production. Fermented food using mold cultures play an important role in Asia and the processes developed there and practiced for millennia could no doubt be applied in other developing countries.

An example of one of these foods is tempeh, a major Indonesian food. Whole soybeans are washed and soaked overnight in tap water. The seed coats are removed and the beans are boiled in water for 30 minutes with the mold *Rhizopus oligosporis*. Small patties of the beans are tightly packed in banana leaves and incubated for 20-24 hours at 31-32°C. At that time the patties are completely bound together with mold filaments. They can now be sliced and fried in oil. The texture and flavor is remarkably good even for the palate of the western world. The mold culture is transferred from batch to batch of the fermented beans and the environmental conditions of humidity and temperature are well suited to its growth.

While mold cultures have been extensively applied in Asia for preparing valuable foods from soybeans fermentations based on milk-souring types of bacteria have not received equal attention. Yet it is clearly indicated that buttermilk and yoghurt types of bacteria products can be made by fermenting soy milks with such cultures as *Lactobacillus acidipholus, Streptococcus lactis*, and *Leuconostoc citrovorum*. Cheese-like products can also be made from soy milk with the help of *Streptococcus thermophilus* (Angeles and Marth, 1971).

The art of fermenting vegetables has been practiced for more than 4,000 years. Cabbages, cucumbers, tomatoes, brussel sprouts, cauliflower, peppers, olives, carrots, and other horticultural products have long been successfully preserved by fermentation.

However, improved technology can surely be applied to such fermentation procedures as by the use of pure mixed cultures, and/or the use of a hot water blanch to pasteurize the vegetables prior to inoculation with suitable cultures of microorganisms. Such improvements can greatly speed the fermentation, prevent spoilage, and produce products of better flavor. There is also the excellent possibility of extending suitably controlled fermentation technology to a great variety of perishable products, such as animal protein foods (fish, meat, and eggs).

Pickling procedures involving the use of such acid as acetic and/or lactic also still offer unexplored possibilities for preserving many perishable foods or food ingredients. The use of such organic acids can by-pass the need for fermentation procedures and the extended time involved. However, one cannot expect the same desirable unique organoleptic properties to be developed as in the case of suitable fermentations.

What Grass-Roots Technology Will Involve

It is hoped that, while not neglecting the great potential of major food technology innovations--spun fiber or thermoplastic vegetable protein extrusion, for example--that grass-roots technology for developing countries will not be neglected. Such technology will involve:

1. Nutritional characterization of hitherto unexplored native valuable food crops;
2. Relatively simple processing steps for rendering these crops ready to use safely as food ingredients;
3. Formulating available food ingredients to make acceptable balanced foods of adequate shelf life;
4. The application of procedures for preservation requiring a minimum of sophisticated processing such as pickling, fermentation, osmotic dehydration, or depressed water activity.

The challenge here to the food technologist, chemist, and engineer is no less than in the case of applying highly sophisticated food technology. A high level of creative imagination and an intimate knowledge of cultural habits and environmental conditions is needed. There is also a need for constantly devising simplified quality control methods and processing systems that are compatible with the limited resources available.

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