LACTIC ACID FERMENTATION

There is a lot of fruit and vegetable waste coming from markets and packing houses that is far too moist to gasify and far too nutritious to compost. It can be fed directly to pigs, goats, sheep, cows, rabbits, chickens and even certain fish. But the direct feeding of such waste is somewhat limited, since it is quickly degraded by bacteria, molds, yeasts, insects and rodents. This leads us to look for a simple and inexpensive way to preserve this material over an extended period of time.

Of course a lot of this waste could be heated and cooked using gasifier heat, but cooking demands time and space, and also, why use heat, if heat is not required? A lot of this waste could be fed to BSF larvae and red worms, but in this case we would be integrating this waste back into the food chain at a low trophic level.

The best solution for certain types of fruit and vegetable waste is lactic acid fermentation. Lactic acid fermentation is one of the simplest technologies available to us, and it has been employed in Vietnam and the rest of Asia for thousands of years.

Here lactic acid bacteria (LAB) consume water soluble carbohydrates (WSC) and produce lactic acid. As the pH drops below 4.2, (sometimes as low as 3.2) the waste is thoroughly pasteurized, and nutrients can be preserved for an indefinite period of time. To get LAB to effect such a drop in pH, certain conditions are required.

There must be more than 150 g/kg in dry matter available WSC in the waste. Many types of waste contain far more than this. If they do not, it is easy to add a bit of molasses. Also the fermentation vessel should be devoid of air. The vegetable matter should be tightly and firmly packed so as to exclude air. The addition of a EM (effective micro-organisms) is also recommended.

Plastic bags are ideal fermentation vessels. A flexible but cheap inner bag can be housed and protected within a more rigid and permanent outer bag. The inner bags are cheap and easily recycled.

Second-hand plastic drums also make ideal fermentation vessels. The 55-gallon drums shown here are available second-hand in Vietnam for roughly 50,000 VND or about $2.75 USD. The drum serves as both a processing and storage vessel. It can be used over and over again.

The market or packing house would have two products to sell: fruit and vegetables for humans, and silage for pigs and other animals. The silage mix, sealed in plastic bags or drums, could be sold and shipped out as quickly as the fruit and vegetables.

Fermenting actually increases the macro- and micro-nutrient content of the fruit and vegetable matter and enhances its digestibility. It is well known that lactic acid bacteria have a beneficial health effect on the intestinal flora of humans and pigs. Pigs fed on this silage would have less gastro-intestinal problems than pigs fed solely on conventional diets.

Some lactic acid bacteria can actually feed upon and render harmless certain insecticides as a source of carbon and phosphorus – pesticides such as chlorpyrifos (CP),[1] coumaphos (CM), diazinon (DZ), parathion[2] (PT) and extremely toxic methyl parathion (MPT).[3] Within the first nine days of fermentation, CP is completely degraded and rendered non-toxic.

Each and every day of the year, Dalat produces over 50 tons of cabbage waste. This represents but one type of vegetable waste among many that could be fermented in the region of Dalat. If fermented, these 50 tons of cabbage waste could provide nourishment to over 16,000 pigs. If fermented, it acquires a value of $50 USD or one million VND per ton, or a total value each day of about $2,500 USD or 50 million VND.

This valuable resource is currently being dumped into valleys and ravines. The levels of leachate and methane produced are horrific. It is hard to imagine a more senseless waste of nutrients, as we see in this picture taken at a packing house in Trai Mat, near Dalat. Each day this one packing house produces about 20 tons of vegetable waste.

Lactic acid bacteria appear naturally in cabbage waste. But to enhance the fermentation process, it is best at add a bit of EM (effective micro-organisms). It takes very little expertise to shred or chop cabbage and blend in molasses and EM. The fermentation process is completed in about one week.

Fishery waste, fish mortalities and fish by-products can be fermented into a highly nutritious protein supplement for pigs,[4] fish and poultry. These wastes acquire a value well over $500 USD (10 million VND). The molasses needed (roughly 15% by weight) for this process is abundant and cheap, and since nothing in this fermentation process has to be heated, proteins are not denatured.[5] Also slaughterhouse waste can be fermented into liquid fertilizers that command a high price.

---

[1] See http://en.wikipedia.org/wiki/Chlorpyrifos for the terrible health effects of chlorpyrifos.

[2] "Parathion is highly toxic to non-target organisms, including humans. Its use is banned or restricted in many countries, and there are proposals to ban it from all use." See http://en.wikipedia.org/wiki/Parathion

[3] See: http://pubs.acs.org/doi/abs/10.1021/jf803649z

[4] Nguyen Thi Thuy shows in her dissertation that by-products from local catfish farming are a suitable protein feed for pigs. These by-products are cheap and can replace fish meal, thereby reducing feed costs. Catfish by-products can be preserved by ensiling, mixed with cane sugar molasses or rice bran. This feed is tasty to the pigs and does not affect the sensory quality of the loin. See: http://diss-epsilon.slu.se:8080/archive/00002370/

[5] See: http://www.fao.org/docrep/003/x9199e/X9199E04.htm

An exciting study conducted in Brazil indicates that shrimp heads and tails can be fermented by means of Lactobacillus plantarum 541 in a simple drum reactor to extract chitin. [6] This fermentation method is surprisingly just as efficient in the extraction of chitin as the chemical method. Lactic acid purifies chitin by hydrolyzing the protein bonded to the chitin. Chitin can be refined and deacetylated into a multi-purpose biopolymer called chitosan,[7] and some grades of chitosan sell from $10,000 to $100,000 US per ton. The liquor by-product from this fermentation process is high in essential amino acids and could be processed into a protein powder fit for human consumption.

In the highland areas of Vietnam, coffee cherries are processed by both dry and wet means. When the coffee cherry is processed by dry means, we suggest that it be gasified,[8] and when it is processed by wet means, we suggest that it be fermented and fed to pigs (see picture of coffee pulp is being loaded into fermentation drums).[9] It takes no more than 5% molasses by weight to convert coffee pulp into a pig feed also valued at about $50 US per ton. The effluent from the wet processing of coffee cherries should be routed to a small, fixed-film bio-digester.

So we see that by means of fermentation, we can quickly transform many types of waste of a high moisture content into feed products of significant value.

---

[6] See Clean Green Technology for Shrimp Biowaste at http://ecosyseng.wetpaint.com/page/Clean+Green+Technology+for+Shrim+Biowaste

[7] "*The chitosan biopolymer has applications in waste water treatment, pulp and paper, in medical and cosmetic products, biotechnology, food and feed and membranes. In agriculture, chitosan has been used in seed, leaf, fruit and vegetable coating, as fertilizer and in controlled agrochemical release, to increase plant product, to stimulate the immunity of plants, to protect plants against microorganisms and to stimulate plant growth. In the latter studies, a positive effect of chitosan was observed on the growth of roots, shoots and leaves of various plants including Gerbera and of several crop plants. Orchid roots sprayed with a very diluted chitosan solution show stimulation of growth, renewed flower production and enhanced resistance against fungi and virus.*" http://www.thaiscience.info/Article%20for%20ThaiScience/Article/2/Ts-2%20chitosan%20as%20a%20growth%20stimulator%20in%20orchid%20tissue%20culture.pdf

[8] The biochar produced from coffee waste is rich in potassium silicate.

[9] See for example: http://www.lrrd.org/lrrd23/7/kass23155.htm