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Potential alternative uses of coffee wastes and by-products

The Executive Director presents his compliments and, for the information of Members, attaches a copy of a paper on potential alternative uses of coffee wastes and by-products prepared by the team working on the reformulation of the project entitled "Use of coffee by-products and alternative uses for low-grade coffee". The project outline was submitted by Costa Rica (document WP-Board No. 942/03) and approved by the Council in principle in September 2003. The development of a full-scale project is now being co-ordinated with the International Centre for Science and High Technology – United Nations Industrial Development Organization (ICS-UNIDO).

Potential alternative use of coffee wastes and by-products

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"Peerless' waste reduction efficiency is a result of management strategy and philosophy"

In coffee producing countries, coffee wastes and by-products constitute a source of severe contamination and a serious environmental problem. For this reason, since the middle of the last century, efforts have been made to develop methods for its utilization as a raw material for the production of **feeds, beverages, vinegar, biogas, caffeine, pectin, pectic enzymes, protein,** and **compost.** The use of fresh or processed coffee pulp has been the subject of numerous studies which, in general, lead to the conclusion that coffee by-products and wastes can be used in a variety of ways, some of which are summarized here.

The Pulp:

Coffee pulp is a waste material from the coffee industry. The reported literature showed that coffee pulp can replace up to 20% of commercial concentrates in dairy cattle feeding, with no adverse effects and a 30% cost savings. Overall results from feeding studies with pigs indicated that corn can be substituted by dehydrated coffee pulp for up to 16% of the total ration, with no detrimental effect on weight gain or feed conversion. This means that at the end of the finishing period, each reared pig has left nearly 50 kg of corn available for human consumption or alternative uses.

Besides pigs, coffee pulp feeding trials were carried out with fish, chicks, lambs, and rabbits. The feeding trials included the determination of daily body weight gain, daily dry matter intake, and feed conversion efficiency. Pigs fed with rations containing up to 15% of coffee pulp ensiled with 5% molasses had equal or better total weight gain than those fed commercial concentrates.

Coffee pulp ensilage is a valid alternative to handling and storing the huge amounts of coffee pulp produced in the factories around the world which process coffee fruits. The inclusion of coffee pulp silage [CPS] in the diets of some farm animals could contribute to lowering the meat and milk production costs, especially in developing countries.

Biogas from coffee waste water:

The water drained from coffee cherry extract is another potential source of biogas production. The cherry extract that has been picked for several hours kept in a bag or in bulk and allowed to heat up, will be a seething mass of micro-organisms of all kinds working on the released sticky fruit juices. Appropriate fermentation and other procedures lower the pH and further neutralization process gives rise to CO_2 foam [mainly acetate salts and raise the pH from 3.8 to 6.1] so formed will float out more solids, principally dark coloured tannins and polyphenolics. Evolution of CO_2 at this point enables the later production of a highly methane-enriched biogas with only half of the usual level of inert CO_2. The clear acetate

solution can then be passed through a UASB digester to make biogas, or, dripped over a suspended curtain as in the aerobic 'Fungal Gulp" process to make **Single Cell Protein** for animal feedstuff. The biogas produced can best be used by running an engine on it to generate electricity, and all the lower grade waste heat from cooling and exhaust can still be used for drying coffee.

Coffee Pulp Solids to Silage:

Coffee pulp is really a very versatile substance, but the presence of caffeine has up to now been seen as a negative factor making it unusable as an animal foodstuff. By a slight dewatering of the pulp, inoculation with commercial silage additives and packing it into plastic liners within FIBCs [Recycling container], or one tone flexible bulk containers, within 3-4 months an excellent foodstuff suitable for cattle feedlots is achievable, bringing extra cash flow during the off season period.

Mushrooms:

In contrast to the larger scale operations required for waste water treatment and silage making, coffee pulp can also be handled on the small-scale family level operation with ease. The fermented and partially dried, pulp can be used as a substrate for growing exotic mushrooms. Of particular interest is the remixing of husk and semi-dried pulp to fast grow in weeks Shiitake, Linchi and other mushrooms that traditionally take many months to grow on billets of cut oak wood. Even quicker is the production of *Pleurotus* or Oyster mushrooms which normally grow on rotting trees in the bush. In areas where mushrooms are a prized food delicacy, smallholder coffee growers can bring in significant cash flow from their local markets.

Coffee Husk as a fuel:

Coffee husk is practically pure lignocellulose and has no fertilizer value at all. It is normally burnt in crude furnaces to dry our coffee parchment. If most of the parchment is partially sun dried for quality reasons then, even with today's crude single pass hot air driers, it is still possible to have a surplus of fuel after a finish drying operation. Burn the husk in a gas producer, and then run an engine on that producer gas to produce electricity. Once again as with biogas, the waste heat from the gas producer and the engine can be used to heat a clean air stream, and that can still be used to dry even more coffee than before.

Coffee pulp solids as Compost:

Coffee pulp solids contain only one fifth of the nutrients taken out of the soil by export of the green bean. However, it is a good source of humus and organic soil carbon. If coffee pulp is turned over every few days in a heap preserved for a few years as in conventional compost making, it will compost in three weeks into one fifth of the original volume of a stable earthy smelling material which does not attract flies. Left to mature for three months under cover, it will reduce further to become very nice dry earthy compost which is a good soil improver and conditioning agent.

It is at the point where the pile begins to heat for the second time, after the first turnover, that the collapse of structure occurs with a massive release of black sticky liquid which contains most of the nutrients and is the real fertilizer material. This liquid should not be allowed to flow away, it should be collected and sold as a high value organic plant nutrition agent and pest deterrent to give an extra source of cash flow.

Alcoholic and soft drinks:

Very little was found on the use of the cherry pulp for the development of soft or alcoholic drinks. In this case caffeine would not represent a problem since it is frequently added to soft drinks and coffee-based spirits are known (Kahlua in Mexico, Caffè Borghetti in Italy).

Coffee mucilage:

From coffee industrial wastes we can obtain the following types of materials in varying states of purity

- **Unrefined pectins**: These pectins can be either thermo reversible soluble gels or non reversible cross linked ones which have a different mouth feel.
- **Natural coffee fruit sugars**, mainly from the recycled pulping water: They are mostly monosaccharides, glucose, galactose, rhamnose and arabinose, with a different flavour, reminiscent of plums, and could be marketed as something new for the more sophisticated coffee connoisseur.
- **Antioxidants and Flavonoid** compounds: These are mainly the anthocyanin fruit colour compounds, but they also contain all the other polyphenolics such as chlorogenic acids and of course caffeine. These materials can be put together into several combinations to make a range of food additives which should be of interest to the 'health food' industry.
- **Colorless Pro anthocyanins:** as a resource base for other food manufacture or perhaps the more sophisticated synthesis of other chemicals.

Health Aspects:

The coffee by-products have many medicinal properties. Some of them are listed here

- **Soluble Dietary Fibre and Heart Disease:** Atherosclerosis, is the loading of our arteries with deposits of cholesterols, (ie. low density lipoproteins or LDLs). Of prime importance are our coronary arteries and the dangers of a heart attack. Coffee pectins also boost the levels of the high density HDLs, which are the really beneficial ones. Pectins are well known for locking up bile acids, (where those cholesterols come from), and taking them on through the small intestine to the colon or large intestine, where some of them become food for bacteria which in turn protect against colon cancer
- **Cation exchange properties:** Pectins, in the form of galacturonic oligosaccharides, are a bit like ion exchange resins. They are able to form complexes with free calcium, iron and other divalent metal ions in the diet and carry them out of the body, seriously reducing the levels of these important nutritional constituents.
- **Antioxidants:** Coffee mucilage, but more particularly the pulp, is not all pectins or protopectins. It also contains a number of linked sugars and polyphenolic chemicals, anthocyanins, proanthocyanins, and cyanidins, bioflavonoids and tannins, not to mention caffeine and chlorogenic acids. It should of course be pointed out that most of these benefits are also conferred by eating lots of fresh fruit. "An apple a day…", particularly ones with red skins, will supply many of these chemicals.
- **Even Caffeine is losing its bad image:** Caffeine and more particularly those chlorogenic acids are particularly good antioxidants. A news clip, 'a cup of coffee is equal to three oranges'.

Fat Replacer: An already well-established technology is the use of pectin emulsions to replace fat emulsions in cooking and the manufacture of salad dressings and mayonnaise. A short paper on a proprietary formulation is appended as an indication of the uses of this material.

The overall thrust of this document is to suggest that realization and utilization of coffee value-added products is the only way of achieving the positive image of coffee and sustainability.