Suitable Material for Biogas Production

(Which is suitable for mono-fermentation or for co-fermentation)

The below listed industry and whose organic residuals, suitable for Biogas are examples and don't claim to be complete. Also other similar organic material which is not listed here could be included into the material balance for biogas production. The sequence of the list doesn't represent a ranking of suitability, but is more or less arbitrary.

Origin	Kind of Material
Agriculture	- Cattle-, Swine-, Poultry Manure [1)], Solid Manure [2)] - Energy Crops (Silage) and on aside-land cultivated Intercrops, Grass, Luzerne (Alfalfa), etc. [3)] - Not sellable Fruits or Fruit Parts (e.g. battered Potatoes, Beets, and Vegetable etc.) - Feed remains, mashed Grain (Triticale), Corn, etc. [3)]
Distilleries and Bioethanol Plants	- Distiller's Wash (Stillage) based on Potatoes, Grain, Corn, Cassava, Jerusalem Artichoke, Agave, Molasses etc. [4)] - Stillage based on Fruits - Of course also the thin slop in case a solid separation for feed production is made. - Possibly organically high loaded cleaning water [5)] - Lutter Water (bubbly residue)
Breweries, Beverage Industry	- Spent Grain, but also the Filtrate if separation is used - Kieselguhr, but also the Filtrate if separation is used - Spent Yeast, - Residual Beer (Product losses) - Possibly organically high loaded cleaning water [5)] - Possibly Hot Trub, Malt Dust etc.
Canneries Fruit and Vegetable Cannery Jam Manufacturer Fruit Juice Manufacturer Producer of Dried Herbs, Dried Onions and Dried Fruits	- Fruit and Vegetable scraps, (sorting, cleaning and peeling waste, partially rotten or damaged goods) - Faulty Batches, overstored Goods - Possibly organically high loaded Blanching, Process or Cleaning Water [5)]
Potatoes Processing Starch Production	- Crop Residues, Pulp, Spent Starch - Amniotic Fluid [5)], Blanching Water [5)] - Condensate (vapor) of drying processes [5)] - Starch containing Wash Water [5)] - Cooking Oil, Grease Trap
Bakery Industry	- Bread remains - Other organic Production Waste (like Flour, Sugar, Fruit residuals, etc.) - Spoiled Vegetable or Animal Fats - Cooking Oil, Grease Trap

Slaughterhouses Meet Processing Factories (similarly Fish Processing)	- Grease Trap, DAF Sludge, Screenings - Rumen, Stomach and Intestinal Contents - Dripping Fat from smokehouse - Manure from Stables and Delivery Area - Organically high loaded Waste Water (partial) streams [5) 6)] - Residual Blood, Meat, Slaughter By-Products and other Condemned Material [6)]
Central Market	- Fruit and Vegetable Leftovers, (also Citrus Fruits!), rejected or not sold Goods, Cleaning Residues (e.g. Beet Leaves or Salad Leaves) - Foods with expiration date - Defective Batches (transportation damages)
Milk Processing	- Separator Sludge, Whey (Sweet Whey and Acid Whey) Whey Water [5)] - Rinsing Milk - Expired or spoiled Good, Reference Samples
Oil-Mills / Biodiesel Production	- Not sellable Press Cake - Spoiled Seeds - Not sellable Glycerin Phase
Sugar Factories	- Wet Pulp, Press Cakes, PMC, Cleaning Residues - Molasses [4)]
Municipal Waste Disposal	- Green Waste, Grass -cut from parks, sport fields etc.[3)] - Kitchen Waste und Food Leftovers from Catering and Canteen Kitchen [7)] - Organic Waste [7)] - Sewage Sludge (primary and secondary sludge) [8)]
Chemical Industry Pharmaceutical Industry	- In Factories in which mainly vegetable, but also animal raw materials are processed under certain conditions (no antibiotics, detergents and solvents in the waste), the production waste, could be come for a biogas plant into consideration, similar to food production or municipal waste.

Remarks to the List above

For anaerobic digestion and thus the production of biogas, in principle, any aqueous organic material is suitable.

In this list we have deliberately avoided the disclosure of possible gas formation rates. The biogas production depends essentially on the composition of the organic matter, i.e. from the content of fat, protein, carbohydrates and fiber. Because of the composition of the materials strongly differ from each other even in apparently similar, such typical specific gas production rates are not more than house numbers.

Basically before making a final decision regarding the suitability of the material and/or material mixture as feedstock for a biogas plant respectively the obligatory specification of the belonging technology, each material hast to be examined and specified on its type and composition. Which such information it's easy to estimate the possible biogas yield in a safe manner.
We have to note that an assumed similar material could have different effects between a plant A and a plant B. Also inhibitors like high salt content, high sulfur concentration, heavy metal concentration or the operational use of disinfectants or detergents as well as antibiotics in higher concentrations could be reduce the anaerobic degradation significantly or could it completely inhibited.
Likewise it’s important to ensure that a suitable ratio of C: N: P: S is present.

Therefore, we should get already with the request detailed information regarding the composition of material which enables us to estimate the suitability. In the pre-planning of the plant, the material flows has to be examined more closely in order to come to binding conclusions.

Which fermenter technology should be used depends on the type of substrate, but also on the task. For structural and fiber-rich substrates, the classic mixed fermenter technique is recommended. Because crude fiber degrades only very slowly, the fiber components provide adequate bacterial immobilization. However, the degradation is limited.

On the other hand, if we have very structure less substrates, like whey, potato stillage or process waters with mostly dissolved organics and the highest possible degradation rate is required, a high-performance fermenter system shall be used, with correspondingly intensive internals for bacteria immobilization. Our *INNOVAS* High Performance Fermenter has as particular advantage the homogenous flow trough, without sustained mixing of the fermenter content, the complete process of fermentation could be measured and monitored and hence controlled.
Thereby, those biogas plants are very reliable and the operator can detect early any material-related disorders (e.g. caused by inhibitors), and can make the necessary counterattacks.

Because we also specify and design the material conditioning as well as the hydrolysis and pre-acidification accurately to the given material or the particular material combination. This enables the operator to dare to materials which are difficult to degrade with simple single-step systems.

Remarks to particular Materials

1) Cattle manure is surely the most unproblematic substrate for a biogas plant and has only little demands on the process technology. With pig (swine) manure we have to pay attention that this is often very strong diluted with water.
   At poultry manure or poultry dung we have to note, such material could contain naturally a relative high part of minerals like sand.
   For larger quantities is therefore important to ensure that this inert parts has to be removed before the fermentation process to prevent a silting-up of the fermenter.

2) At digestion of solid manure it must be checked which kind of litter is used in stable. Saw dust or wood shavings are generally not digestible but would only burden the system. Thereof a separation would be recommended.
   Straw is only (partial) digestible after a mechanically or enzymatically disintegration which breaks down the lignin structure. With high parts of straw a mechanically crushing is recommended as well as the digestion in a two-step fermentation.

3) Green waste, Grass, Grass Silage or Maize Silage etc. can easily – with the accordingly conditioning - be used as feedstuff for a biogas plant. As basic material or to come to a better and continuously utilization of the biogas plant (e.g. if there is a campaign production like in a distillery). But one should only deal with the more water containing fraction. Means rather fresh grass cuttings than old hay from roadsides, no wood and no old dry leaves and no bushes and tree clippings.

   In case that dry biomass like grain, flower or dust should be digested it must be well diluted with (waste) water or mixed with other more aqueous materials.

4) On the processing of molasses or molasses stillage we have to pay attention on a possibly high content of sulfur. In such cases suitable processing technology are required for reducing the sulfur content down to an acceptable level.
   The same effect could be happened at potatoes, corn or grain stillage if the distillery is using extraordinary quantities of sulfur acid in its process.

5) Organically high loaded waste waters are generally suitable for the anaerobic digestion but shall be taken into account only if the biogas plant is located closed to the factory or otherwise if the disposal fees are higher than the transport costs.
Often the effluent load (COD/BOD) is much too high for an aerobic treatment but too thin for a significant biogas production. Nevertheless in such cases the use of an anaerobic process with special kind of fermenters (like UASB) could be meaningful and profitable for saving high waste water costs.

6) On digestion of Animal by-products (slaughter waste), catering waste and food leftovers etc. it is certainly to observe the European Hygienic Regulation "(EC) No. 1069/2009" (Laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation)) and other national laws like in Germany the "TierNebG" (Tierische Nebenprodukte Beseitigungsgesetz = Animal By-Products Disposal Act).
As well as it's conforming to all legal requirements regarding hygiene the digestion of such material can be considered as unproblematic.

7) Organic waste, kitchen waste, food leftovers, packed food etc. are generally very good for biogas production. However such material needs a prior removal of impurities like plastic, metal, glass etc.
Related to the utilization of the digested substrate as fertilizer great caution is required at this point. In such cases one should deal only with material which is well known in its composition and in its origin. The risk that pollutants (like heavy metals etc.) are coming to the fields by this way must be strictly excluded.
All belonging relevant legal regulations and law must be considered. In Germany thus are et.al. "BiomasseV" (Bio Mass Regulation), "BioAbfV" (Bio Waste Regulation), "AbfG" (Waste Act), "TierNebG" (Animal By-Products Disposal Act), "TA SiedlAbf" (Technical Instructions for Urban Waste), "Duengemittelverordnung" (Fertilizer Regulation), several (state) legal water regulations, in extreme cases also the "AbfKlaerV" (Sewage Sludge Regulation).

8) Sewage sludge is principally well digestible and this is state of the art since decades. But unfortunately sewage sludge from municipal waste water treatment plants are often charged with sand. Therefore special designed egg-shaped fermenters (also called as fermentation towers) are mostly used for digestion of sewage sludge.
But sewage sludge from an in-house WWT doesn't have such restrictions in most cases.

The utilization of digested sludge as fertilizer is usually strong regulated, controlled but only allowed in exceptional cases. Beside the "AbfKlaerV" also the "Duengeverordnung" (Fertilizing Regulation) must be considered and the sewage sludge must be analyzed before use.




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