Evaluating physiological and environmental consequences of using organic wastes after technological processing in diets for livestock and humans – SAFEWASTES

The fruit, vegetable and herb processing industry produces millions of tons of organic wastes, by-products and residues year by year. Today's technology for re-using and further processing of these waste materials is limited due to little knowledge on potentially useful primary and secondary plant products still contained in the residues.

Apart from depositing, composting or in some cases using organic wastes as such in animal feeding, some tentative results led to assume that many of these by-products might be valuable starting materials for food and feed additives with significant health benefits for animals and human beings. By the way, some of the disposal and environmental problems could be solved and economic benefits achieved for the respective industries.

The Specific Targeted Research Project SAFEWASTES combined 12 partners from feed and herb industry SMEs, universities and research institutions of 12 European countries with expertise ranging from phytochemistry, microbiology, nutrition and veterinary medicine to food and feed technology, industrial manufacturing and environmental protection. After selecting more than 10 candidate starting materials to be obtained in large amouts every year (among them: Mango peel, Artichoke pomace and Horse chestnut disposal water), the Austrian-led project started by developing innovative biotechnological processes for food and herb wastes from the plant-based industry to recover valuable compounds. The next steps have been phytochemical evaluations and *in-vitro* tests of the fractionated material.

Pre-requisite standard operating procedures (SOP's) have been developed for the process technology (production of extracts out of organic waste material – solvents: water, ethanol, heptane), for the bioassay guided fractionation and for several *in-vitro* tests. *In-vitro* test systems have been developed and validated for

- testing anti-parasitic activity (protozoan parasites Cryptosporidia and Coccidia)
- testing anit-pathogenic activity (efficacy of products against *Histomonas meleagridis, Tetratrichomonas gallinarum* and *Blastocystis spp.*, frequent and problematic pathogens in poultry)
- testing the influence of organic wastes in caecal bacteria growth of pigs with a colon simulation technique
- testing anti-microbial activity, and also anti-oxidative activity

Already in the first year the results have shown that most of the 'waste material' contains more bioactive substances than expected. A number of fractions is highly antioxidative, many extracts showed very good COX-2 inhibitory activity indicating prevention against inflammations, and some of the fractionated material was very active in preventing the adhesion of pathogenic microorganisms at the gut mucosa (the latter causing e.g. diarrhoea). In the mentioned fields, an exploitation through patents is expected.

The SAFEWASTES project is on the right way to develop organic feed additives to replace in-feed antibiotics, which use has been banned within the EU. SAFEWASTES will help food manufacturers (two agreements have been signed with companies being not partners of the project) employing scientific approaches to meet consumer demands for safer, higher quality food. Animal welfare is one of the key issues within the politics of the EU which in addition should lead to better food products. The organic waste material from industry shows already high potentials for the use as new, natural and functional products that will improve the quality of life of animals and also humans.

The first promising results out of the phyto-chemical analysis and the initial *in-vitro* tests are a good basis to proof that compounds in the selected residue material will contribute to anti-microbial activity in the gut through a reduction of pathogenic microflora and stabilisation of physiological microflora. The already tested materials show also effects to prevent diarrhoea in animals, but also to reduce methane production.

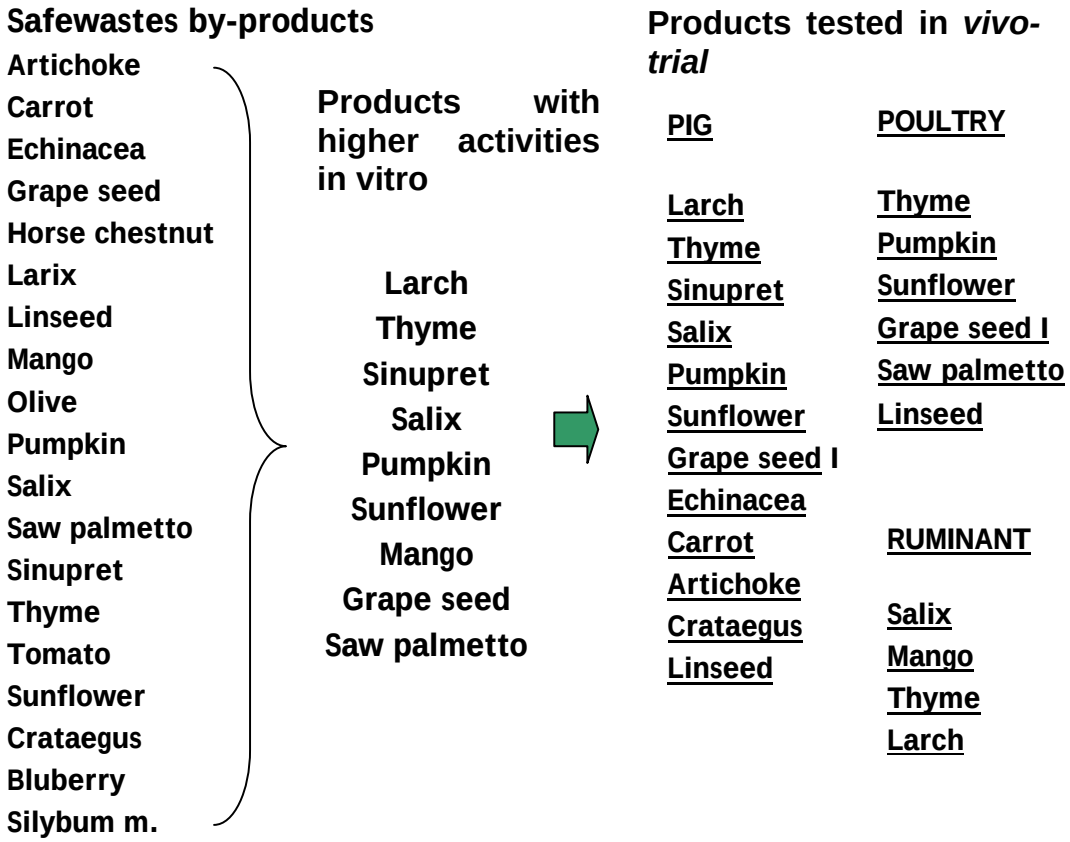
Organic waste material at the 1000 kg scale was provided for in vitro and in vivo testing. High costs arose for drying of the fresh plant residues, which is an important factor to be considered when evaluating economic assessment criteria. While the environmental benefits of utilizing plant waste materials as value added products for use in animal and human nutrition seem clear, the value of the products obtained must compensate for the costs arise for recovering them. After standardization of the extraction technology at laboratory scale, large scale extract production at pilot plant scale was performed in order to obtain sufficient amounts of extract material to be used in Workpackage 3 and 4. Enzymatic hydrolysation of SAFEWASTES materials was optimized at laboratory scale and transferred to pilot plant scale for the production of SAFEWASTES-hydrolysates to be tested in vitro and in vivo. Adsorptive purification of phenolic compounds was exemplarily evaluated for artichoke extracts. Adsorbertechnology proved to be a powerful tool for the production of food grade extracts rich in antioxidant phenolic compounds.

In contrast to expectations the “waste materials” showed absolutely high antioxidant activity. Of course the results strongly depended on the starting material, but even after OPC-extraction high quantities of antioxidant activity remained in materials known for high antioxidative capacity like, for instance, grape seed.

The following list shows the main results out of in-vitro testing, mainly extraxts with the highest activity measured:

- ANTI-OXIDANT
  - Grape seed, Sunflower, Larch, Olive, Salix, Carrot, Mango, Saw palmetto
- ANTI-FLAMMATORY
  - Grape seed, Larch, Sinupret, Salix, Pumpkin, Thyme, Mango, Sunflower
- IMMUNE-METABOLICAL STIMULATION
  - Thyme, Sinupret, Larch, Sunflower, Saw palmetto, Salix, Crataegus, Mango, Pumpkin, Echinacea , Linseed, Olive
- ANTI- OR PROMICROBIAL GUT
  - Artichoke, Thyme, Pumpkin, Echinacea, Larch, Linseed, Carrot, Salix, Olive, Tomato
- ANTI- OR PROMICROBIAL RUMEN
  - Carrot, Mango, Larch, Grape seed, Pumpkin, Sinupret, Thyme, Salix, Crataegus
- ANTI-PARASITIC
  - Saw palmetto , Thyme, Grape seed, Larich, Olive, Sinupret, Salix, Pumpkin, Carrot, Mango, Sunflower, Crataegus

On the basis of these results which are summarised within an online material database, the following substances were identified as promising candidates for the in-vivo testing.



Selection process of promising SAFEWASTES material

In particular trials were performed per:

- Species :
  - Pigs
  - Ruminants (Sheep and cows)
  - Poultry (Turkeys)

- Research field:
  - Gut Health (Diarrhoea score, Villi : Crypt - ratio)
  - Antimicrobial (against E. coli, Salmonella spp, Lawsonia, Staphylococcus, Streptococcus)
  - Antiparasitic (against Histomonas meleagridis)
  - Antiinflammatory
  - Growth promotion (Acceptance and performance)
  - Antioxidant activity (lipid oxidation in milk and meat).

At the end of the trials, the positive control showed some compensatory growth, mainly due to a lower feed conversion ratio. The reason for this lower feed conversion ratio is unknown, because the negative control (= same diet, except for the infection) does not show this effect.

Lowest growth is obtained with pumpkin (RM). Probably, pumpkin serves as a nutrient for *Salmonella*, encountering animal growth (competition for nutrients).

Remarkable is that larch shows consistently the lowest villus/crypt ratio and the lowest % IEL's in the ileum. Combining with a less crypt depth, this can indicate less damage of villi and thus less contamination of the gastrointestinal tract with *Salmonella*. This indicates also that virulence of *Salmonella* is lowered by larch.

Again pumpkin shows increased % IEL's at ileum level, indicating heavier microbial contamination. Under infection conditions, none of the SAFEWASTES products alter the normal gastrointestinal ecology It is clear that both SAFEWASTES products have a positive effect on diarrhoea and general health of the animals.

In conclusion, from an **zootechnical** point of view, **larch (RM)** scores better, from a **health** point of view, **pumpkin (RM)** scores best. **Sinupret, Thyme, Pumpkin, Linseed, Sunflower, Salix, Crataegus and Larch, measuring and evaluating the following parameters: ADWG, ADFI, FCR and Mortality.**

Based on the assumptions of better health and performance the feed additives Mango, Larch, Pumpkin and Thyme could be interesting ingredients for feed for pigs and poultry. Small percentages of 2.5 to 10.0 % of the additives can be added for those positive effects. The most interesting feed to add these additives are those for sows, broilers and parent stock. Maximum prices for the additives when maximum positive effects are assumed, are above € 100 per 100 kg. Even when smaller positive effects are assumed, maximum prices for the feed additives are calculated round € 50 per 100 kg. It may be beneficial for both the producer of Safewastes residues and the pig farmer to feed these products to gestating sows.

List of partners

- University of Veterinary Medicine – Austria (Co-ordinator)
- Karl-Franzens-Universität Graz - Austria
- Institute for Animal Science and Health – The Netherlands
- University of Hohenheim – Germany
- University of Thessaloniki – Greece
- Università degli Studi di Udine – Italy
- Università degli Studi di Milando – Italy
- Bionorica – Germany
- Vitamex, Nutriton Science NV – Belgium
- Biomin – Austria
- Institute of Soil Science – Poland
- RTD- Services - Austria

Website: http://www.safewastes.info