Research Summary Sheet

Deliverable n°: 1.1 (Task 1.5)

"Key indicators and methodologies for assessing the impacts on soil, water, air quality and human safety of agro-waste management".

Direct impact through Feedstock Logistic

Source of harmful effect / Types of contaminants: Microbiological risk

Impacts on human health

Several pathogens are present in agricultural waste. Getting into contact with a pathogenic organism does not necessary mean that an individual will become ill as it is influenced by several factors such as virulence of the microorganism, susceptibility of the people. Epstein (2008) review that levels of relative hazards of different feedstocks for composting facilities: and summarized that medium to high levels of pathogens can be found inn biosolids such as manure. Medium levels of pathogens were found yard trimmings, which suggest that the NoAW project need to consider this risk for straw and winery waste.

Pathogens can get into the people by different routes. In work environment – like farms, composting facilities, biogas plants - they can cause infection by passing into the people through mouth by the results of unclean hand but such way is rather atypical for occupational infections. Pathogens may also cause infection by inhalation of bioaerosols.

Microbiological risks in manure

Many potential pathogens for livestock as well as humans can be found in manure of both livestock and poultry. These pathogens include bacteria, protozoan and viruses.

The most frequent pathogens in livestock manure include bacteria such as Shiga-toxin producing Escherichia coli (E. coli), Salmonella, Campylobacter and Yersinia. These bacteria can cause fever, diarrhea, vomiting, nausea, and abdominal pain in human. Protozoa such as Giardia and Cryptosporidia can be found in manure and cause illness. Other important aspect, that these protozoa cannot be not easily destroyed from waters except by filtration. Viruses are less frequent but can be present in manure. The most commonly recognized is the rotavirus and these can survive for long periods of time in the environment depending on conditions. (Spiehs and Goyal 2007)

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Microbiological risks in straw

Most of the workers have some reaction to dusty conditions during harvest, which is made up of both organic and inorganic particles (mould and mould spores, Insect parts and excerta, bacteria, endotoxins) which can be inhaled easily. These particles get into the respiratory system causing a range of adverse health effects. The exposure can cause different conditions with very similar symptoms like "Farmer's Lung" or Hypersensitivity Pneumonitis, which is an allergic reactions or "Organic Dust Toxic Syndrome" which is a toxic reaction.

Microbiological risks in winery waste

Pathogens may be presented in winery waste. M.A. Bustamante et al (2007) monitored some microbial indicators and pathogen content (sulphite reducing clostridia, total enterobacteriaceae, total coliforms, Escherichia coli, enterococci, Staphylococcus aureus and Salmonella spp.) in winery waste to evaluate the effectiveness of the composting process in reducing the pathogen content.

Threshold levels

DIRECTIVE 2000/54/EC provide a list of agents which are known to infect humans and classify them based on the effect on healthy worker but in these document qualitative aspects can be found only.

There are no existing guidelines for community levels, but a number of countries published occupational limit values. The following levels are acceptable but these are guidelines and not based upon dose-response relationships or health measures. Pearson et al. (2015)

- 1000 cfu/m^3 for total bacteria.
- 300 cfu/m^3 for gram-negative bacteria
- 500 cfu/m^3 for Aspergillus fumigatus

Control measures

DIRECTIVE 2000/54/EC lays down the minimum requirements of protecting workers against risks to their health and safety, including risk assessment, the prevention of such risks, arising or likely to arise from exposure to biological agents at work.

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It highlights the importance of replacement harmful biological agent if feasible, reduction of risks, applying following the good hygiene practices, providing individual protection and keeping workers informed and trained.

Bibliographic references

Mindy Spiehs and Sagar Goyal, Best Management Practices for Pathogen Control in manure, M1211 2007 Copyright 2007 © Regents of the University of Minnesota.)

Eliott Epstein (2008), Protecting workers at composting facilities, BioCycle Magazine, 2008 ©The JG Press, Inc.

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DIRECTIVE 2000/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 September2000 on the protection of workers from risks related to exposure to biological agents at work

Pearson C, Littlewood E, Douglas P, Robertson S, Gant TW, Hansell AL. (2015) Exposures and Health Outcomes in Relation to Bioaerosol Emissions From Composting Facilities: A Systematic Review of Occupational and Community Studies. Journal of Toxicology and Environmental Health Part B, Critical Reviews. 2015;18(1):43-69. doi:10.1080/10937404.2015.1009961.

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Source of harmful effect / Types of contaminants: Physical/Dust explosion

Impacts on human health

Pretreatment of waste, such as milling, can produce dust that can explode if mixed with air in a cloud formation, and with a source of ignition present. It can cause serious injuries therefore the presence of dust can be one of the indicators for human safety.

Threshold levels

Health and Executive Committee (GB) (last accessed in February, 2017) provides guidelines for the prevention of dust explosions in the food industry. This guideline gives the concentration ranges which can cause explosion and precautions for prevention), which can be applied for managing and manipulating dry, milled agro waste. The typical concentration ranges for fine powder that can give rise to an explosion are low from 75 to 1000 g/m^3 of air. As a guide, it explains that at these lower concentrations it is difficult for an observer to distinguish solid shapes at distances of 60cm or less.

According to WHO study (1999) high risk of explosion exists where concentrations of combustible dust exceed 10 g/m^3.

Control measures

Workplace directive 99/92/E contains the minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres. It describes the obligation of the employers, which includes risk assessment and classification of areas into zones where hazardous explosive atmospheres may occur and drawing up and keeping up-to date the explosion protection document.

CFPA Guidelines No 31:2013 provides guidelines and measures for protection against self-ignition and explosions in handling and storage silage and highlights that that in normal farming activity the risk of dust explosion is very low and can be controlled by good housekeeping.

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Typical examples of preventive measures are the followings: adequate storage and handling, selection and use of vacuum cleaners, pneumatic conveying systems, chokes, sizing of explosion relief vents, ducting explosion relief vents to open air.

Bibliographic references

CFPA Guidelines No 31:2013; Protection against self-ignition and explosions in handling and storage silage

Health and Executive Committee (GB); Prevention of dust explosions in the food industry (http://www.hse.gov.uk/food/dustexplosion.htm), Last accessed: February, 2017

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WHO/SDE/OEH/99.14, Hazard Prevention and Control in the Work Environment: Airborne Dust DIRECTIVE 1999/92/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

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Direct impact through Feedstock Logistic

Source of harmful effect / Types of contaminants: Biological/Endotoxins

Impacts on human health

Different studies showed that in biogas plants - simirarly to agrucultural activities - during the different operations (biomass storage, loading and unloading) workers could be exposed to bacterial endotoxins. The source of endotoxins is the lipopolysaccharides (LPS) in the cell walls of Gram-negative bacteria derived from decaying wastes. Even low concentrations (200 EU/m^3) can cause the stimulation of the mucous membrane, respiratory diseases up to chronic inflammations of the respiratory system. In biogas plants increased endotoxin concentrations (>50 EU/m^3) could be related to operations with aerosol formation (e.g. cleaning activtites). In addtitions, large amounts of agricultural feedstock are often handled in biogas plants and there is a high exposure to inhalable fungal spores and bacteria including actinomycetes in the air at working areas. Both epidemiological and experimental studies confirm that these exposures are associated with development of hypersensitivity pneumonitis, organic dust toxic syndrome, decline in lung function, severity of asthma, respiratory symptoms and airway inflammation (Pietrangeli et al., 2013)

Threshold levels

The threshold levels often expressed in endotoxin units (EU), where one EU equals approximately 0.1 to 0.2 ng endotoxin/mL. An exposure limit of 50 EU/m^3 has been recommended by ICOH Committee on Organic Dust in 1997 (Pietrangeli et al., 2013). The Dutch Expert Committee on Occupational Standards of the National Health Council has proposed a health-based recommended limit value of 4.5 ng / m^3 (0.45 EU / m^3) over an eight-hour exposure period. (BARTH et al, 2009). The Norwegian 8-h time weighted average (TWA) organic dust occupational exposure limit (OEL) of 5 mg / m^3 (HALSTENSEN et al, 2007).

Control measures

Personal protective equipments are the first lines of defence in order to prevent the intake via the respiratory tract.

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Direct impact through Feedstock Logistic

Source of harmful effect / Types of contaminants: Chemical/Enzyme

Impacts on human health

Enzymes can be used for the pretreatment of different agro wastes. Enzymes act as catalysts to speed up the chemical reactions in different processes. Skin contact with proteolytic enzymes can cause skin irritation; in this case irritation is caused by properties of the proteases and is not an allergic response. Inhaling high levels of enzyme-containing aerosols may result in coughing and/or congestion due to irritation of the mucous membranes of the respiratory tract. Repeated inhalation of enzyme contained in aerosols can cause an allergic response for the susceptible individuals (simple medical tests are available) but it is not possible to predict who will develop an allergic response.

Enzyme preparations have been used in the manufacture of foods and in industrial processes for many years. Commercial enzymes can be used safely without any adverse health effects through the use of good work practices, so there is no need to include as specific indicator of human safety.

Threshold levels

American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value (TLV) for only one class of enzymes, subtilisins, of 60 ng/m^3 as a ceiling limit.

Control measures

There are air-monitoring techniques available to measure the level of enzyme dust or mist in the air. Both low-flow and high-flow air sampling methods are available for some enzymes. For protecting the health of the workers emphasis must be put on safe handling practices, use of personal protective equipment, respiratory protection, protective clothing and gloves.

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Direct impact through Feedstock Logistic

Source of harmful effect / Types of contaminants: Chemical/Solvents

Impacts on human health

Solvents can be used for extraction steps in the valorisation process agro-wastes. Most solvents have Occupational Exposure Limits. These limits apply to workers directly involved with tasks using solvents and also to other workers in the workplace who may be exposed to solvents indirectly from these operations. Depending on type and concentration of the solvent it can cause irritation, dizziness, headache, vomiting, kidney problems, or it can be carcinogen. Solvents can produce toxic gases and vapours when they burn or chemically react with other substances. Therefore the presence of solvents can be one of the indicators for human safety (Government of Alberta, 2009).

Threshold levels

Directive 2000/39/EC establishing a first list of indicative occupational exposure limit value for chemical agents. The limit values are given for a reference period of eight-hours-time-weighted average (TWA) and short term exposure (STEL) related to a 15-minute period. DIRECTIVE 2006/15/EC contains additional occupational exposure limit values for further chemicals.

The limits values for some frequently used solvents:

- Diethylether : 8h TWA 308 mg/m^3 (100 ppm), STEL 616 mg/m^3 (200ppm)
- Acetone : 8h TWA 1 210 mg/m^3, (500 ppm), no indicative value for STEL
- (2-Methoxymethylethoxy)-propanol: 308 mg/m^3 (50 ppm) no indicative value for STEL
- n-Heptane: 2 085 mg/m^3 (500 ppm)
- n-Hexane : 72 mg/m^3 (20ppm)
- Methanol 260 mg/m^3 (200 ppm)

Control measures

Control measures for solvents can be the followings: use of personal protective equipment, substitution with a less hazardous material, using of engineering controls (e.g.: proper ventilation, enclosure around process) and changes in work practices to reduce exposure. (Government of Alberta, 2009)

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Bibliographic references

COMMISSION DIRECTIVE 2000/39/EC of 8 June 2000 establishing a first list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work

COMMISSION DIRECTIVE 2006/15/EC of 7 February 2006 establishing a second list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC and amending Directives 91/322/EEC and 2000/39/EC

Government of Alberta, Workplace health and safety bulletin: Solvents at work sites, CH013 — Chemical Hazards 1, Revised September 2009

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