Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Design, Industrialization, Life Science and Engineering for Agriculture, Food and the Environment

Subfield: (Biorefinery design, food technology, engineering and process optimisation)

Title:**Valorization of Insects and larvae into high-value functional proteins: eco-design, modelling and energy assessment**

ParisTech School:

Doctoral School ABIES (Agriculture Food Biology Environment Health)

Advisor(s) Name:

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(Lab, website):Researcher in Joint Research Center JRU1145 Food Process Engineering (France)

Short description of possible research topics for a PhD:

Problem statement: Self-sufficiency and food security is a major issue that requires exploring new nutritional resources. Insects and larvae are sources of protein and lipid and would be the ideal, nutritious and ecological food. The production of food grade functional proteins and other high-value ingredients requires the development of insect extraction and purification processes.

Objectives of the PhD thesis: The overall objective of this research is to conduct a detailed expertise of insect fractionation process by considering technical feasibility and energy performance. Given the range of by-products that can be separated from insects, this project aims to extend the scope of the study towards an insect biorefinery design.Thanks to a thermomechanical fractionation it is possible to obtain a delipidated protein meal. This product must be dried in order to be stored safely and then used as an ingredient or additive for animal feed. In addition, the isolated lipids can be recovered as liquid-fuel to produce a heating utility (steam or hot water). Lipids can also undergo an esterification transformation to be upgraded to biofuel potentially used in cogeneration process.The specific tasks are: (a)conduct air- and SHS- drying experiments by using a lab-scale dryer and find out the effect of various process parameters on the drying kinetics and the product quality. (b) Develop a mathematical model, to predict the temperature and the moisture profiles of the drying product. (C) investigate the energy efficiency by combining drying technology using SHS and air at low temperature, and to determine operating conditions that maximize the net energy gains while satisfying constraints on the product quality. (D) Perform an energy assessment to evaluate the possibility of producing a biofuel from the lipid fraction and ensure an energy self-sufficient for the insect biorefinery.

Required background of the student: (food technology, biotechnologies)

A list of 5(max.) representative publications of the group: (Related to the research topic)

Maillard F., Macombe C., Aubin J., **Romdhana H., Mezdour S.** (2018) Mealworm Larvae Production Systems : Management Scenarios, in Edible Insects in Sustainable Food Systems pp 277-301

Romdhana H., Goujot D. (2018)towards a simple, generic and rapid simulation of the drying of solid foods, LDRT2018-0302.R2 (accepted in drying technology)

Lambert C., Laulan B., Decloux M., **Romdhana H**. (2018) Simulation of a sugar beet factory using a chemical engineering software (ProSimPlus®) to perform Pinch and exergy analysis. Journal of food ing, 225, 1-11.

Chriyat Y., **Romdhana H.** (2018) A concept and industrial testing of a superheated steam rotary dryer demonstrator: Cocurrent-triple pass design, Drying tech,1-7.

Azagoh, C., Hubert, A., &**Mezdour, S.**(2015). Insect Biorefinery in Europe "DESigning the Insect bioRefinery to contribute to a more sustainable agro-food industry". Journal of Insectsas Food and Feed, 1(2), 159-168.

Azagoh, C., Ducept, F., Garcia, R., Rakotozafy, L., Cuvelier, M.-E., Keller, S., Lewandowski, R., &**Mezdour, S. (**2016). Extraction and physicochemical characterization of Tenebrio molitorproteins. Food Research International, Volume 88, Part A, October 2016, Pages 24-3.