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Bioconversion by insects

Nutritional and technical considerations to be taken in account when engineering a cost-effective diet for BSF

ADEBIOTECH – Romainville

Bioconversion by Insects: what is it all about ?

- ✓ **We recycle** agriculture and food industry leftovers and by-products.
- ✓ **We are multi-source** : we offer recycling services to all producers.
- ✓ **We are local** : we collect from less than 80 km around.
- ✓ **We upgrade** : our farms are **Protein Refineries**.
- ✓ **We are high quality** : our products are high grade and traceable.

Which Feedstocks are eligible for Bioconversion ?

- ✓ Allowed by **Regulations**.
- ✓ **Suitable** for Larvae
- ✓ Allowing a **guaranteed quality** of final products.
- ✓ Can undergo **industrialized processes**.

Regulations for insect feedstocks

Insects are « livestock », to which the following European regulations apply :

- CE n°999/2001
- CE n° 142/2011
- CE n° 1069/2009
- Directive 97/78

Allowed Feedstocks :

- ✓ Fruits and vegetables from producers, wholesalers, retailers.
- ✓ By-products from vegetal products transformation (grain mills, sugar extraction, oil mills, fruit juice producers...).
- ✓ A limited number of non-vegetal raw material of 3rd Category (EU Reg n°1069/2009)
 - CE n°999/2001
 - Fish meal,
 - Blood products from non-ruminants,
 - Hydrolysed Proteins from non-ruminants,
 - Gelatine and Collagen from non-ruminants,
 - Eggs and egg by-products,
 - Milk, milk-derived products,
 - ...

Regulations for insect feedstocks

Annexe III of EU Reg N° 767/2009 specifies forbidden feedstocks:

- ✓ Transformed Animal Proteins
- ✓ Urines, Faeces,
- ✓ All wastes from water and waste water treatment plants,
- ✓ Urban Solid Wastes
- ✓

Feedstocks that are Suitable for Larvae ?

We can cope with material with no economic value, rotten, smelly, moldy...



Feedstocks that are suitable for Larvae ?

...but Larvae are livestock and they have their own **requirements !**

- ✓ The **Rearing Substrate** resulting from the Feedstocks must be **nutritive** and **digestible**
 - **Proteins:** BSF Larvae are not “poly-gastric”, **no protein = no growth**
 - **Carbohydrates:** to provide energy for larvae life and to constitute their reserves
 - Preferably **low Lipids**,
 - pH and Salinity under control,
 - No anti-nutritional factors, no toxics (**beware insecticides !**),
 - No bactericides that would jeopardise the larvae gut microbiota.
- ✓ The substrate must be **liveable** because it's their home:
 - with a good consistence allowing the larvae to crawl through the entire thickness of the substrate while breathing easily : not sticky, not oily, porous, aerated,
 - moisture must be in the range 60% to 80%,
 - parasites must be under control (domestic flies, molds).

Feedstocks must be healthy !

CertiFLY

Processes for controlling health safety applied to bioconversion by insects.

ADEME



Agence de l'Environnement
et de la Maîtrise de l'Energie



WHAT WE MUST GURANTEE for OUR PRODUCTS :

- ✓ **Absence of chemical toxicity**
 - Heavy metals,
 - Dioxines, PCB,
 - Pesticides residues,...
- ✓ **Absence of biological risks**
 - Vertebrates Parasites and Viruses
 - Zoonotic Pathogens *Salmonella*, *L. monocytogenes*, *E. coli*, *C. perfringens*, *Campylobacter*
 - Mycotoxins *Aspergillus*, *Penicillium*, *Fusarium*, *Patuline*
 - Prions

HOW WE ACHIEVE THE GOAL THROUGH FEEDSTOCK MANAGEMENT :

- ✓ **Prior Feedstock source acceptance:**
 - Register provider, understand his production processes and related risks.
 - Lab. Analyses on samples.
 - Larvae growth Tests.
- ✓ **Upon Feedstock delivery:**
 - Check conformity with prior acceptance
 - Control Lab Analyses.
- ✓ **During production:**
 - Traceability at each stage.
 - Process (detect/separate foreign bodies)

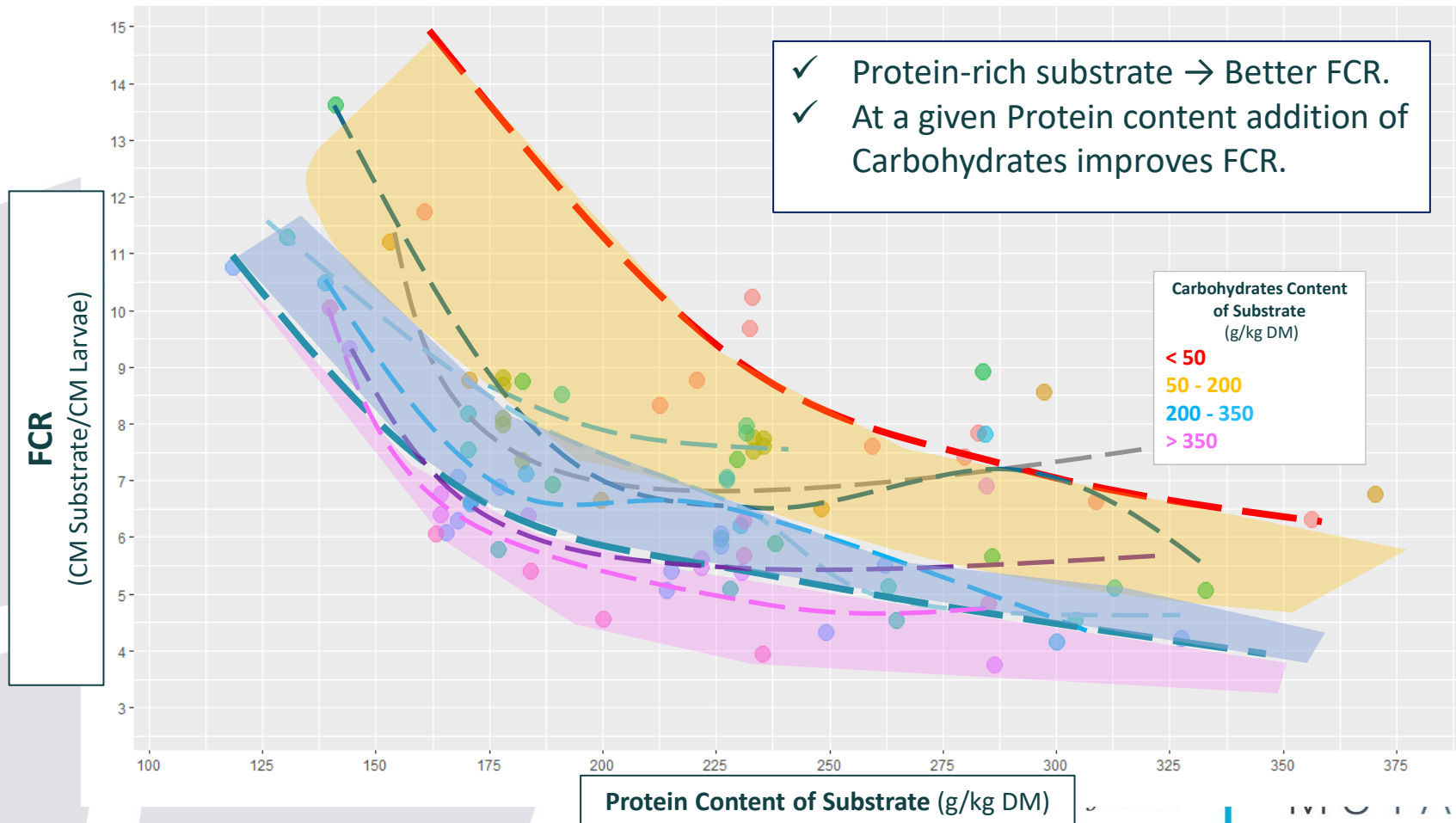
Feedstocks must be suitable for industrial processes

Industrial mass rearing of insects for constant controlled and high quality products imposes specific “**technical requirements**”.

- ✓ **Dry Matter** of substrate must be adjusted very accurately :
 - Larvae metabolism generates a lot of heat and moisture evaporation, therefore the substrate tends to get too dry before it is entirely digested : a “**minimum starting moisture content**” must be respected.
 - On the contrary, once digested, the substrate must be sufficiently dry to allow for a clean separation of larvae and frass : a “**maximum starting moisture content**” is therefore also requested.
 - The ideal moisture content depends on climate and rearing conditions : it usually stands between 72% to 76%.
- ✓ To obtain an easy and clean **separation of frass and larvae**, greasy and sticky matters, hard parts such as kernels and stones, long fibres must be eliminated.
- ✓ Nature of feedstock and its **Protein/Carbohydrates ratio** have a major influence on ammonia and odour emissions of the farm.

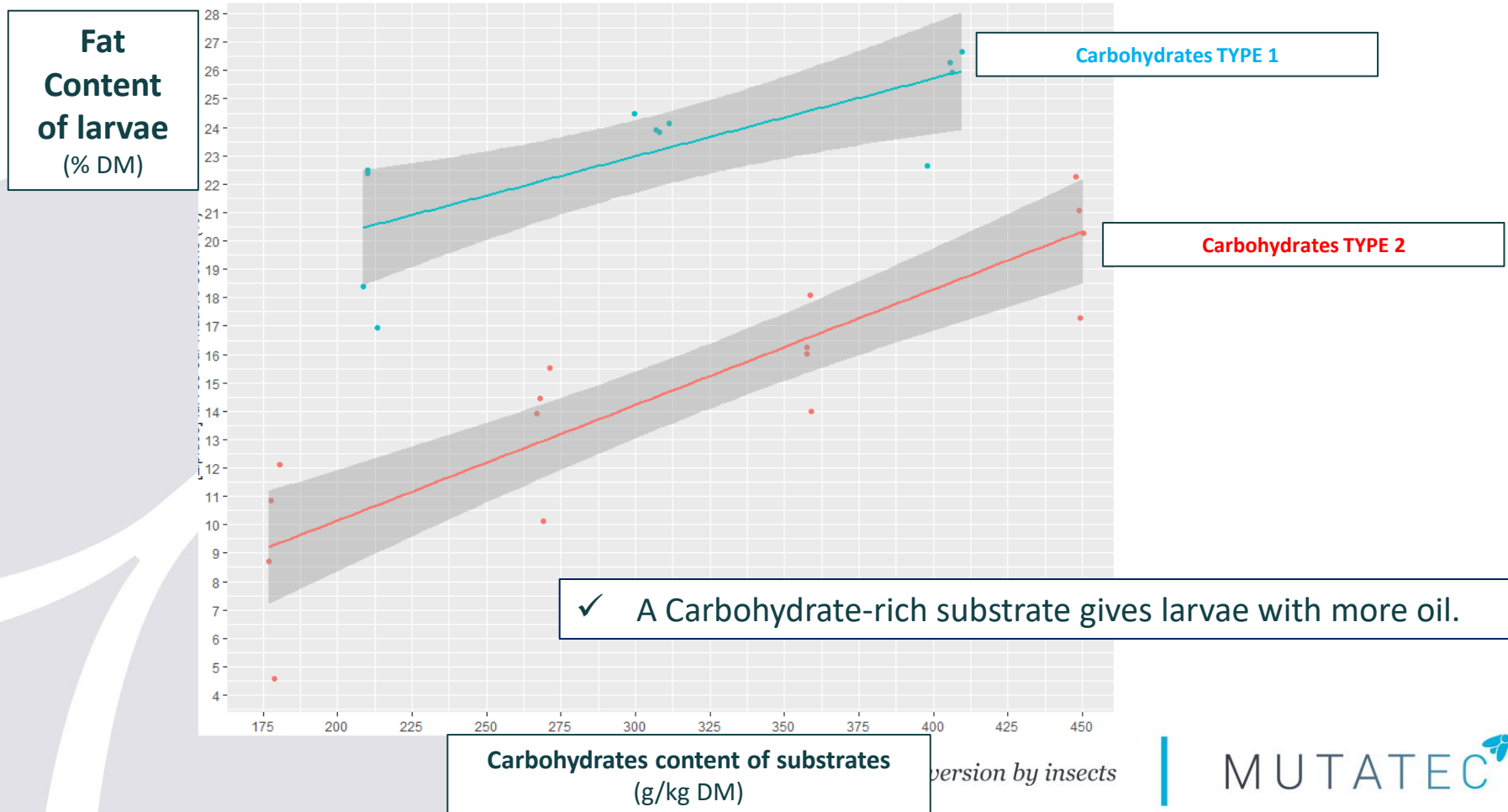
Last, but not least : feedstock is the key for profitability !

What quantity of larvae do you get out of your feedstock ?
Nutritional quality of feedstock drives the Feed Conversion Ratio (FCR) !



Last, but not least : feedstock is the key for profitability !

What quality of larvae do you get with your feedstock ?
Nutritional quality of feedstock influences the Larvae Composition



Last, but not least : feedstock is the key for profitability !

To select, mix and give the fair value to the feedstocks you need :

- ✓ Experience on larvae nutrition
- ✓ Data on feedstock
- ✓ Modeling tools



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Objective	SELECT OR ENTER DATA
Settings	
Results	DO NOT CHANGE
Calculations	

SELECTION OF FEEDSTOCKS AND FORMULATION

	Units	1	2
		Fruits Peels + Stones 02/22	Bakery leftovers
% DM	%	9,8	77,0
ASH	g/kg DM g/kg RM	61,0 6,0	27,0 20,8
PROTEINS	g/kg DM g/kg RM	82,0 8,0	97,0 74,7
ETHER EXTRACT	g/kg DM g/kg RM	102,0 10,0	79,0 60,8
SUGARS + STARCH	g/kg DM g/kg RM	102,0 10,0	700,0 539,0
CRUDE FIBERS	g/kg DM g/kg RM	240,0 23,5	8,0 6,2
FORM (Shovelable/Liquid/Powder)		Shovelable	Shovelable
Cost delivered to farm	€/T RM	1,0	20,0
Cost of DM	€/T DM	10,2	26,0
Cost of Protein	€/T Prot DM	124,4	267,8
Cost of Sugars + Starch	€/T S+T DM	100,0	37,1

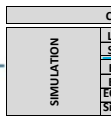
Quantities of Feedstocks Incorporated	tons FW/year
Porportion of Each Feedstock Incorporated	% of FW

260	200	60
100,0%	76,9%	23,1%

SIMULATED COMPOSITION AND FCR OF RESULTING SUBSTRATE

		REQUIRED	ACHIEVED
Quantities of Feedstocks Incorporated	tons FW/year	100	260
TOTAL QUANTITY OF DRY MATTER	t		66
% DM	%	25% - 28%	25,3%
ASH	g/kg DM g/kg RM	<100 <30	37,1 9,4
PROTEINS	g/kg DM g/kg RM	140-200 35-60	92,5 23,4
ETHER EXTRACT	g/kg DM g/kg RM	< 35 < 9,5	85,9 21,7

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