Desirable

insect biorefinery

Partenaires publics

AgroParisTech — irstea — cnrs — cea — INRA

Conception d'une bioraffinerie d'insectes pour contribuer à des systèmes agroalimentaires plus durables

DESigning the Insect bioRefinery to contribute to a more sustainABLE agro-food industry

Janvier 2013 - décembre 2016

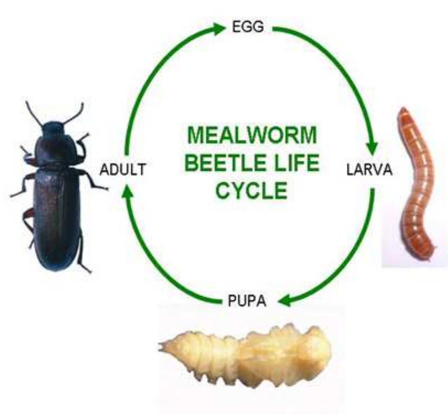
Partenaire industriel

Ynsect

ANR — Agence Nationale de la Recherche

ProgrammeALID Edition 2012

AXE 2
"Conception de filières ou de systèmes agro-alimentaires plus durables"



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Vers une filière industrielle

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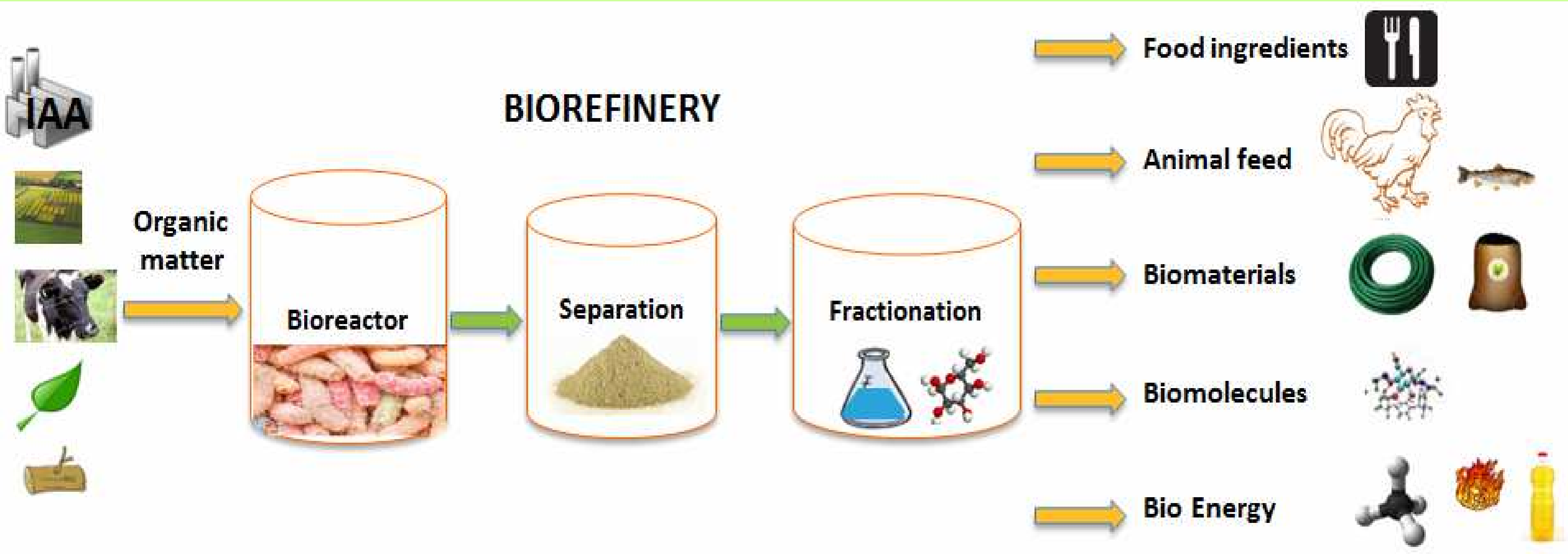
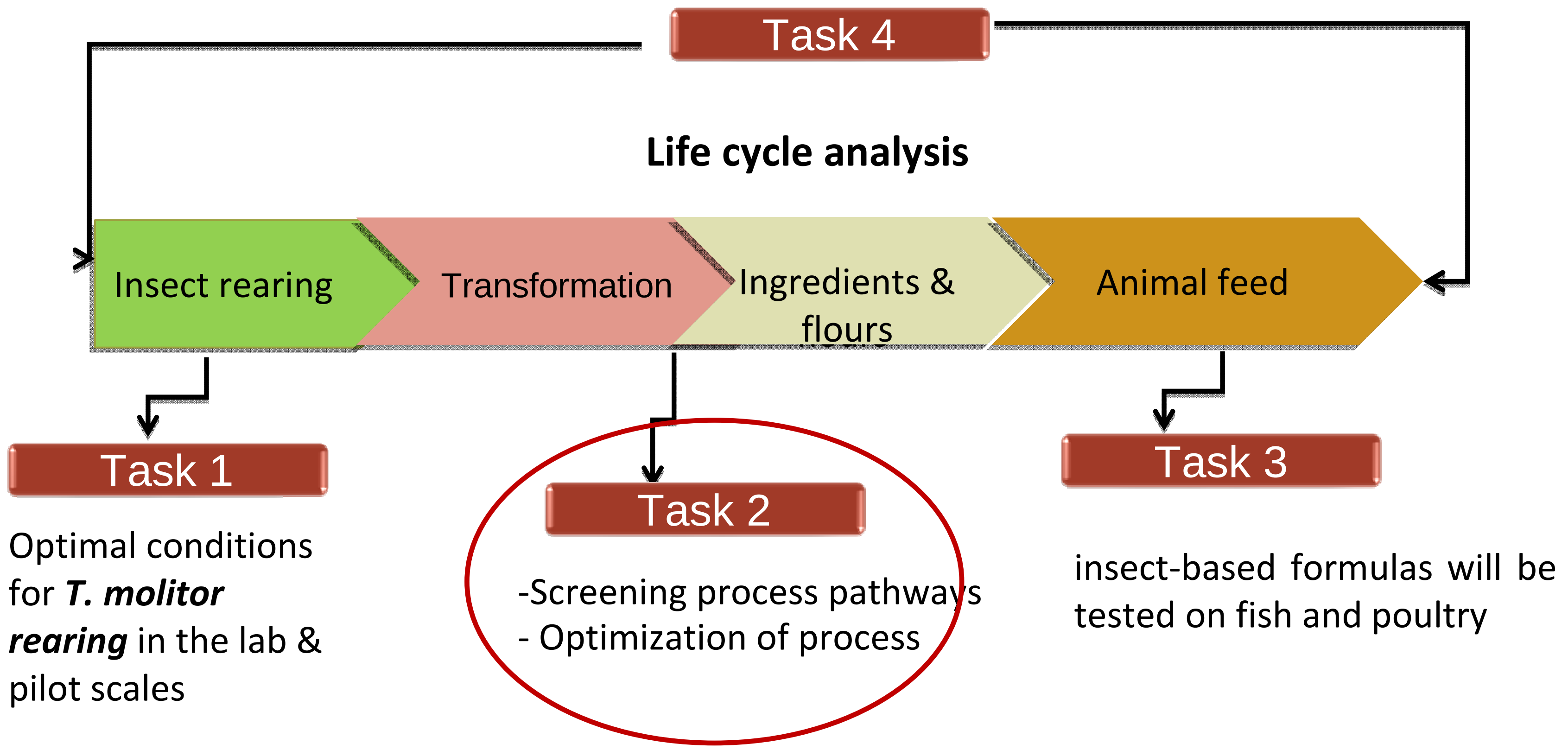
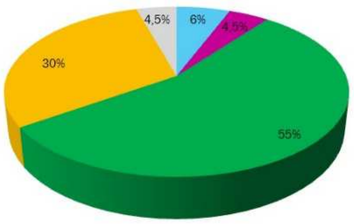


Analyses de Cycles de Vie

évaluation sociétale

Vers une filière industrielle

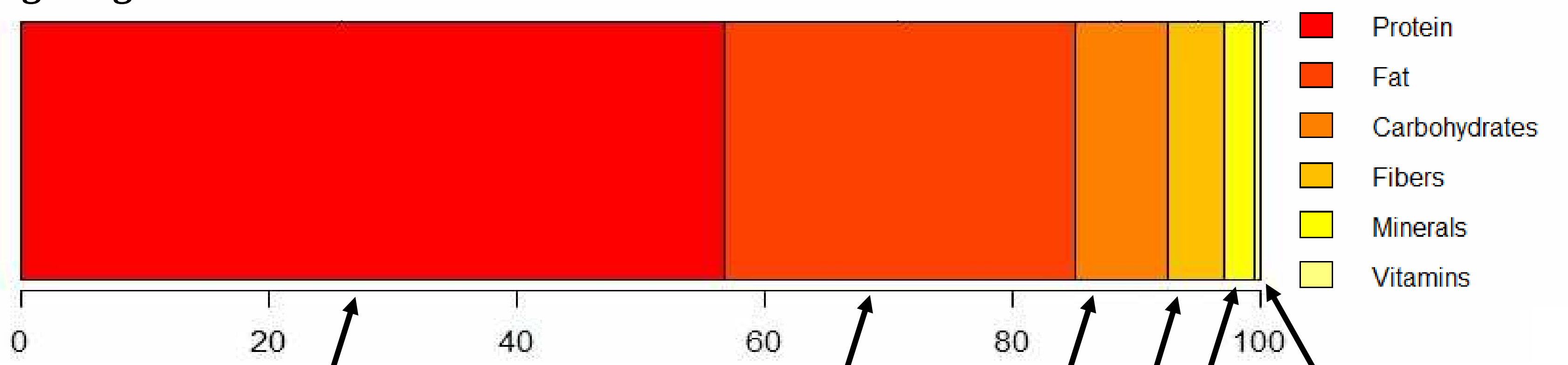




Composition de la larve de ténébrion (ver de la farine)

Tenebrio Molitor

g/100g de matière sèche



Protéines 56,8%

Lipides 28,2%

Fibres 7,5%

Minéraux 2,5%

Glucides 4,5%

Vitamines 0,5%

*Sources: Aguilar-Miranda, 2002 ; Leyuan Li, 2012 ; A.E.Ghaly, 2009, *Ramos-Elorduy, 1989*

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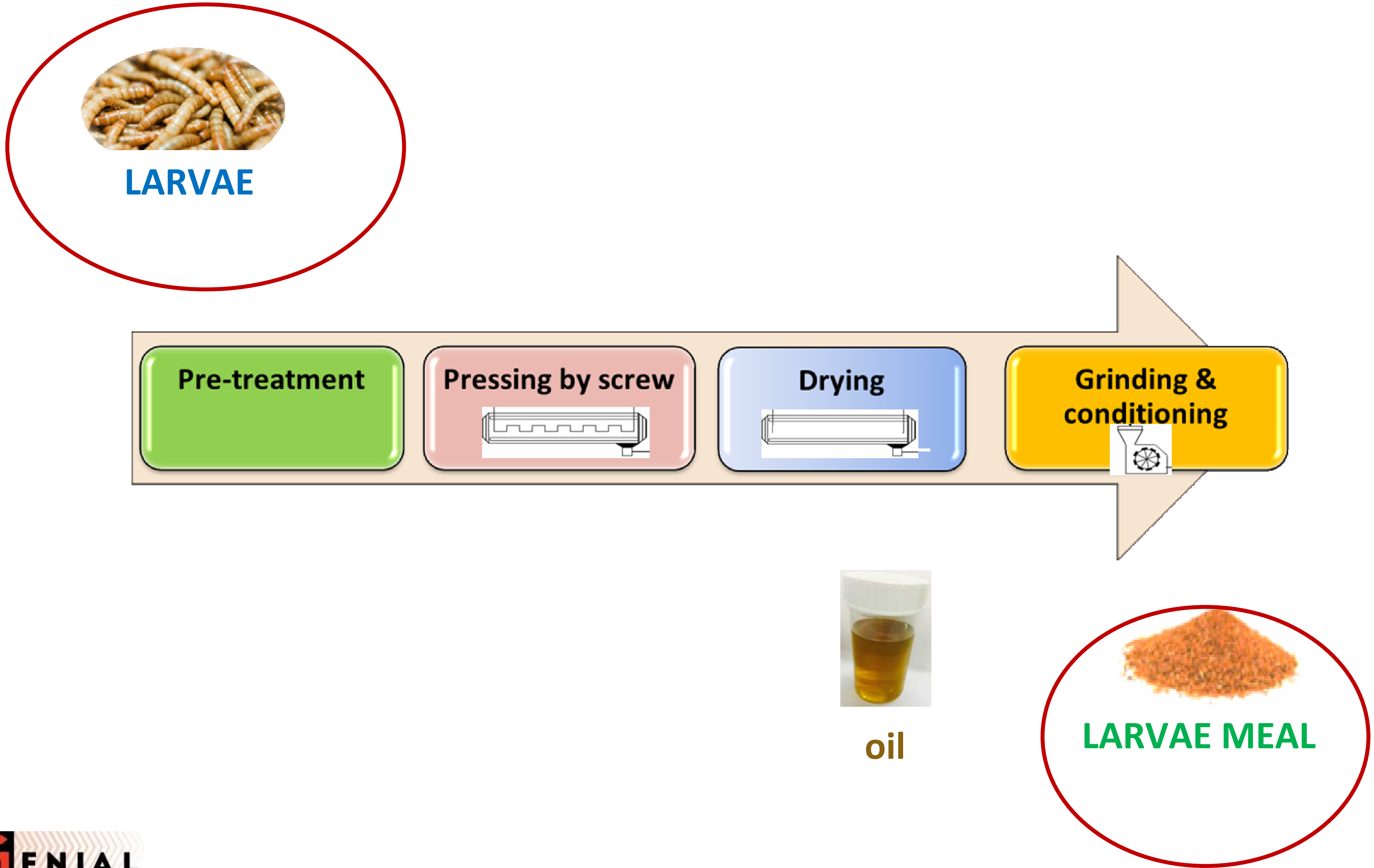
LARVAE
Pre-treatment
Pressing by screw
Drying
Grinding &
conditioning
oil
LARVAE MEAL

Protein and fat contents of mealworm meal compared to fish meal and (defatted) soybean meal*

Protein source	Protein content (% dry matter basis)	Lipid content (% dry matter basis)
Mealworm meal	***66-72***	***12-15***
Fishmeal *	61-77	11-17
Soybean meal (defatted) *	49-56	3

[*]d'après Veldkam T et al, 2012

AgroParisTech INRA SCIENCE & IMPACT

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Essential amino acids in mealworm meal compared to fish and soya meals (% dry matter basis)

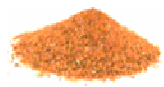
Amino acid	*Tenebrio molitor*	Fish meal *	Soybean meal *
Arginine	3,76	3,99	2,90
Cystine	0,59	0,82	0,74
Histidine	1,99	1,36	1,02
Isoleucine	3,18	2,97	2,07
Leucine	5,43	4,45	3,29
Lysine	4,27	4,55	2,63
Méthionine	0,94	1,68	0,52
Phénylalanine	2,45	2,35	2,12
Thréonine	2,95	2,60	1,66
Tryptophane	0,81	0,69	0,65
Tyrosine	4,03	1,98	1,27
Valine	5,78	3,09	2,06

* Aniebo A O, Erondu E S and Owen O J (2008)

Alkaline extraction of soluble proteins from larvae and larvae meal

Larvae

Larvae meal



Alkaline extraction

↓ ↓

Larvae ← Soluble proteins → Larvae meal

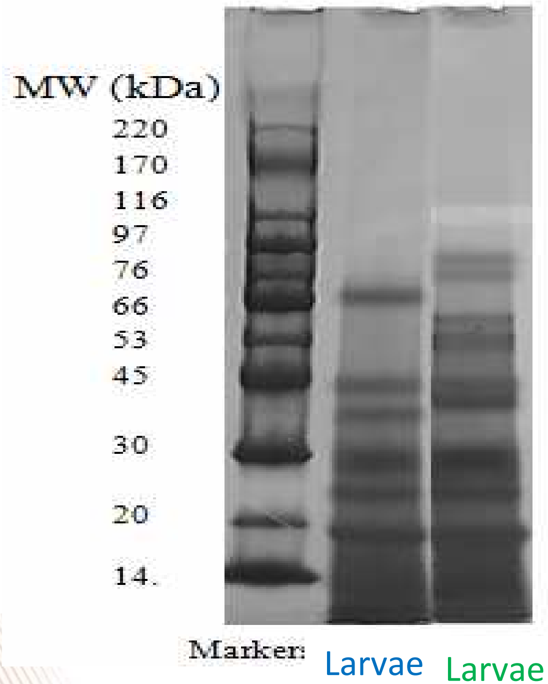
Physico-properties of soluble proteins from larvae and larvae meal

- Molecular weight
- Solubility
- Surface charge
- Surface hydrophobicity

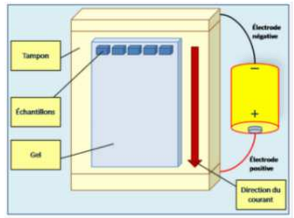
Larvae

Larvae meal

Molecular weight determination of soluble proteins by electrophoresis



Larvae Larvae meal



- Same range of molecular weights (< 100 kDa)
- Different proteins (similar to Yi et al, 2013)

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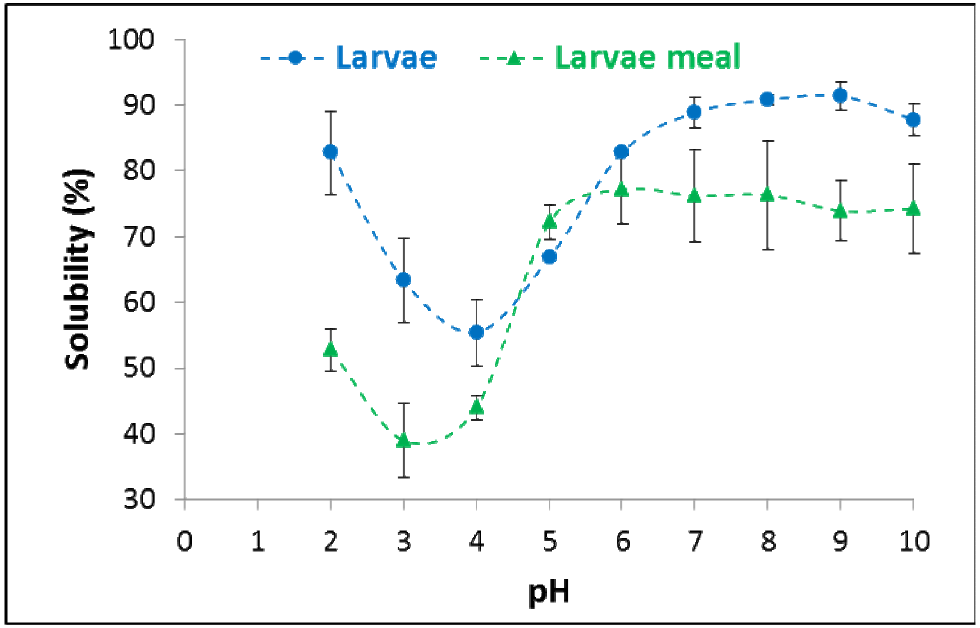
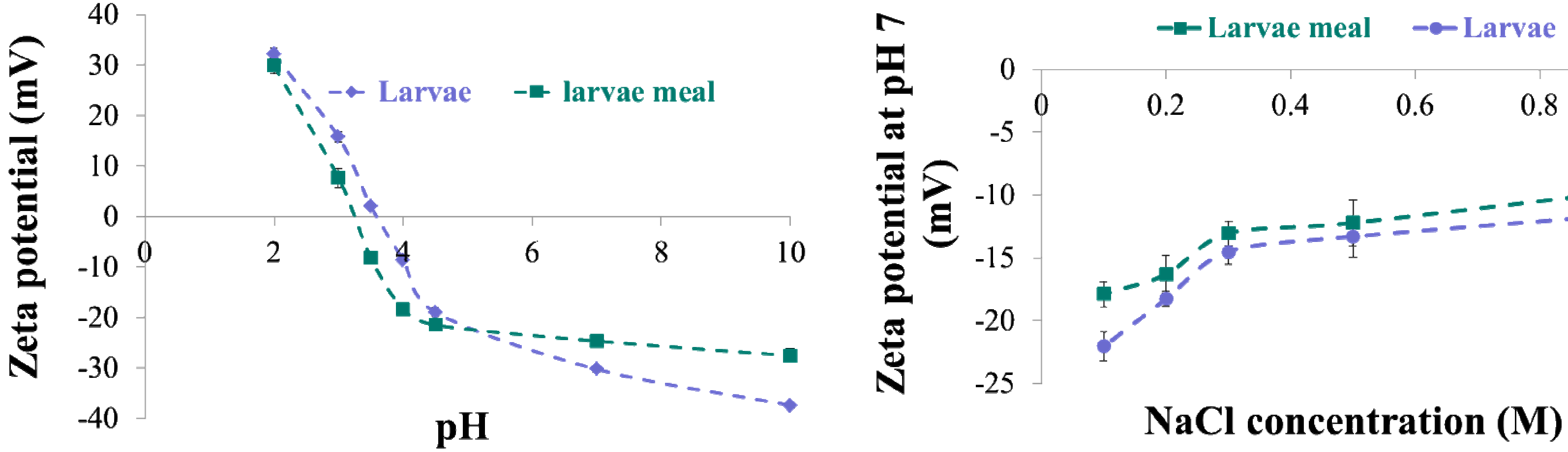
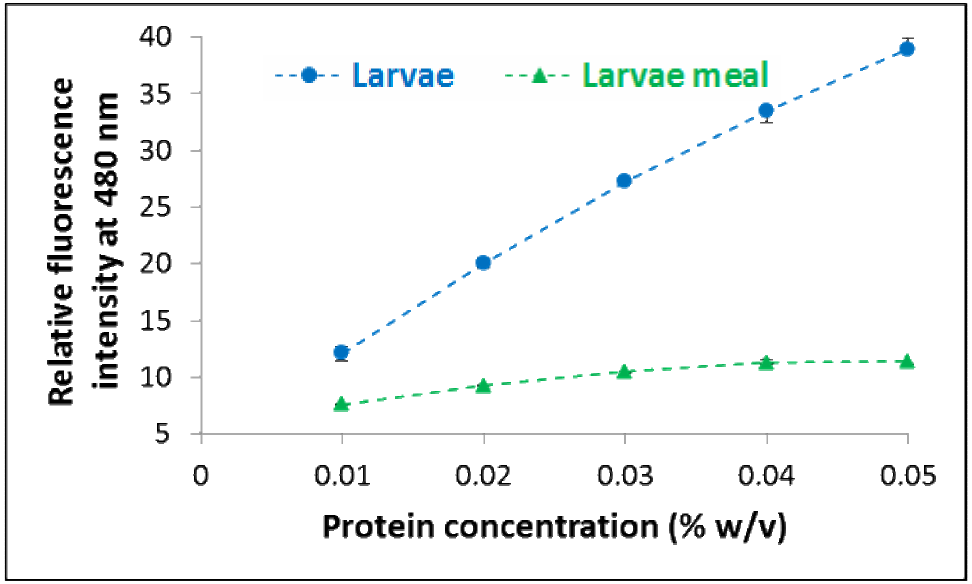
Solubility of soluble proteins from larvae and larvae meal in water at 25 °C



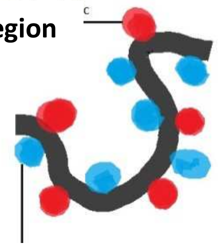
Surface charge of soluble proteins from larvae and larvae meal



Surface hydrophobicity of soluble proteins from larvae and larvae meal by fluorescence with ANS (25 °C, pH 7)

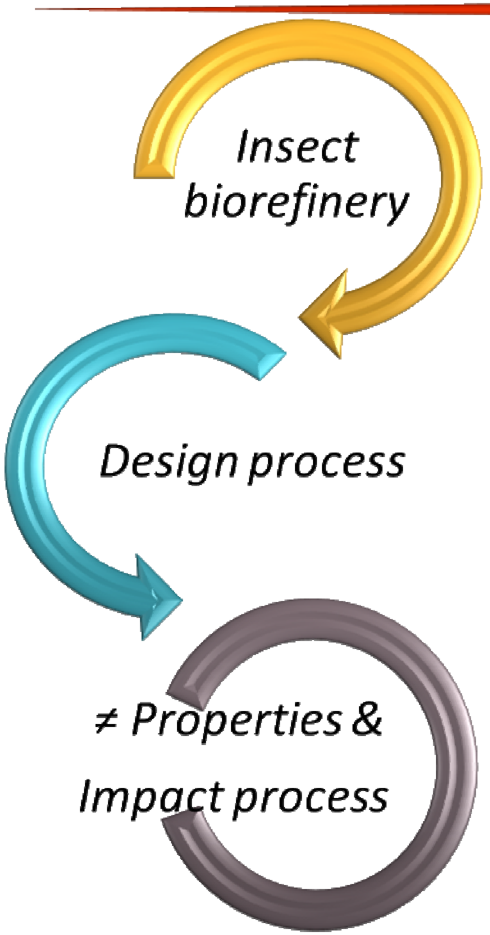


Hydrophobic region



Hydrophilic region

→Orientation at interfaces (mix immiscible liquids)



Conclusions

- Insect biorefinery is designing through different projects and research

Desirable project case:

- Process designed at the pilote scale

→Production of insect meal rich in proteins (70% proteins)

→Production of insect oil for feed, food or other applications

- Nutritional properties (EAA acids) > fish and soya meal used in animal feed
- Different proteins with same range of molecular weights (< 100 kDa)
- Solubility, surface hydrophobicity, surface tension for larvae > larvae meal
- Assessment of digestibility on fish, chicken
- Assessment of foaming and emulsifying properties and difference between proteins from larvae and larvae meal

Study in progress for better knowledge

▪Assessment of life cycle analysis

…Isolation and characterization of insect proteins, feed formulation, study on other insects…