Side-stream substrate formulations for mealworms in Finland

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Background

Cultivation of crops used in production substrates is one of the main sources for greenhouse gas emissions in insect production. Replacing them by local side-stream materials is critical for the economic and environmental sustainability of insect production. At the same time, good productivity requires understanding the nutritional requirements of the produced insects.

Mealworm (*Tenebrio molitor*) has potential to feed on a wide range of biomasses, but nutritional requirements are inadequately understood. In particular, we aimed to find domestic side streams and other protein-containing raw materials that could substitute imported feed ingredients (soybean, maize grits) and domestic ingredients directly usable as food (wheat, oat).

Methods

In total we tested 15 formulations using two mealworm strains. We conducted four trials, each with 5-6 treatments. Each treatment was done as 4-5 replicates per trial. Each replicate had 150 larvae and had 300 g feed + fresh vegetables. Larvae were grown for four weeks in controlled conditions (at 24.2 ± 0.2 ˚C , 60.3 ± 1.4 % RH) in row-column experimental design. Growth and viability was measured and recipes were further developed after each trial. Eight side-streams were tested: potato protein, beer mash, barley feed, fishmeal, cold pressed rapeseed, dried pea, faba bean and carrot meal.

Results

Among the formulations, crude carbohydrate, protein and fat contents were 58-70%, 11-18% and 2-9%, respectively. Average growth was 58 - 78 mg (Fig. 2). Using the best formula, the growth was 35% better than in the chicken feed control, despite the nutritional compositions at macronutrient class level did not differ greatly. Survival was very good (>95%) on all substrate formulations. We observed compositional differences (*e.g.* fat and protein as well as in fatty acid composition) in the mealworms even among the well performing formulations.

Discussion

The results confirmed the feasibility of the investigated side streams as feed ingredients for mealworm. Crude macronutrient class proportions did not appear as a sufficient information to predict growth of mealworms. For example, the high carbohydrate formulation (70% crude carbohydrates) described in Fraenkel (1950) did not differ from the more balanced formulations, based on the formulation by Suomalainen (1999). The situation could be different when not fed *ad libitum*.

Both nutritional and economical factors need to be balanced in the substrate formulation. Potato protein, a side-stream of starch production, is an interesting ingredient. Unfortunately, it is not much less expensive than fishmeal. However, when combined with cold pressed rapeseed it becomes a competitive local candidate for replacing soya in Finnish mealworm production.

References:

Fraenkel 1950. Physiological Zoology 23:2, 92-108

Suomalainen 1999. Herpetomania 5-6/1999

The project *Safe and sustainable feed for insects from domestic side streams of bio-economy (HyväRehu)* studied use of side-streams in the diets of mealworm (*Tenebrio molitor*), house cricket (*Acheta domesticus*), two spotted cricket (*Gryllus bimaculatus*) and nsenene bush cricket (*Ruspolia differens*).

The poster presents the mealworm experiments performed at the Luke InsectLab -center of Natural Resources Institute Finland. The center focuses on black soldier fly (*Hermetia illucens*) and mealworm (*Tenebrio molitor*) research.

More at: http://tiny.cc/InsectLab

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Fig 1. On left, adult and larval *Tenebrio mollitor*. On right, picture of experimental setting.

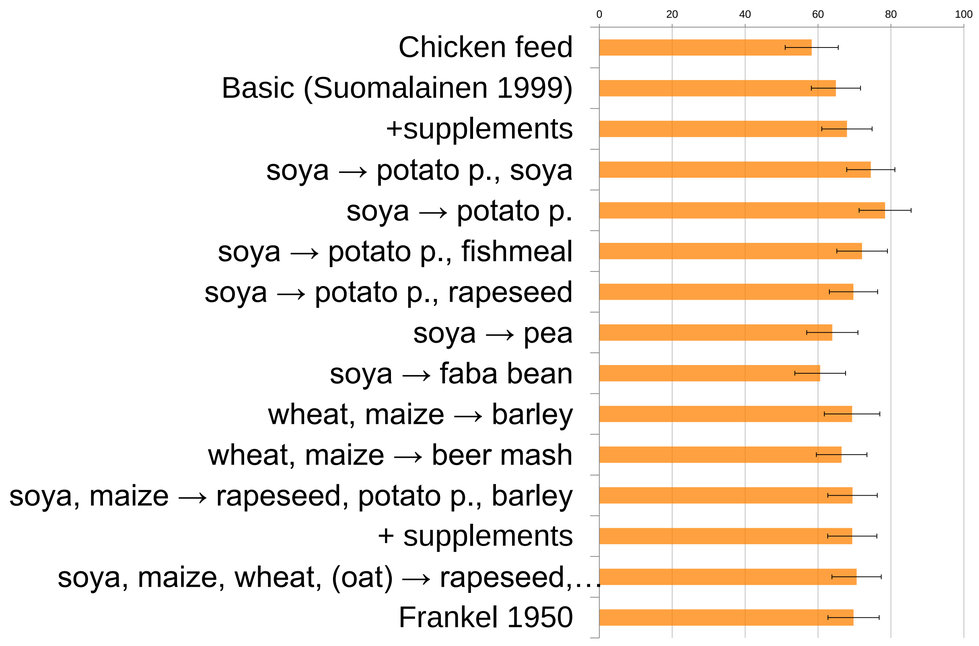

Fig 2. Larval growths on tested formlations. Formula names describe the design target. Tje second last full label would be ” soya, maize, wheat, (oat) → rapeseed, potato p., barley, carrot”. Designs also required tuning other quantities (not shown). Basic substrate was based on Suomalainen (1999). Frankel ”optimal” formulation incljudes wheat and 5% brewery yeast.