



**SUSINCHAIN**  
SUSTAINABLE INSECT CHAIN

## **D5.2 Final specifications and batch production plans for six insect-based products**

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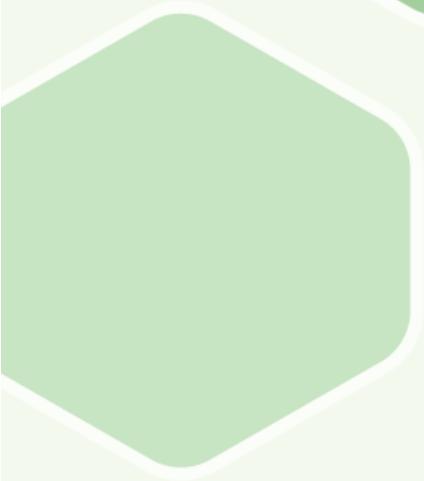
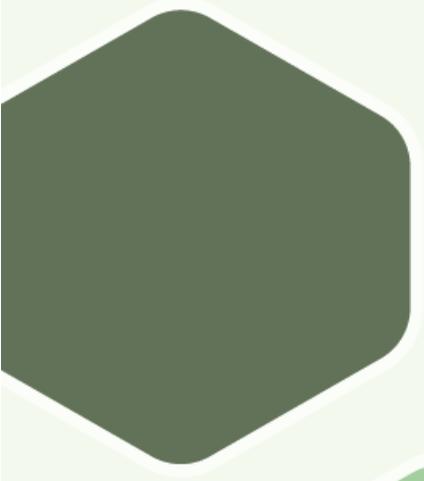
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# CHAPTER 1

Introduction

## Chapter 1 – Introduction

### 1.1 Summary

#### 1.1.1 Progress of the work

This report covers the outcomes of activities carried out in task T5.1 (products development) and partially in task T5.2 (preparation for product batch production) and T5.3 (sensory and acceptability testing). The insect-based products described are based on the early prototypes and the quality criteria reported in D5.1. These criteria are the reference for the project partners (KUL, UNIVPM, NGN, LEITAT, BD and DTU) responsible for the product development and production to be tested in the T5.4 consumer trials.

The March 2020 COVID-19 lockdowns across the partner countries severely delayed the work of the partners involved in various ways and this deliverable was therefore approved to be rescheduled from M12 to M17. By submission date of this report, specifications for the six improved products have been developed. The batch production plans for T5.4 servings are available for five of the six products. The plan for one product remains to identify the production facility.

#### 1.1.2 The insect-based products

The products developed are based on three different insect species, applied in the products as fresh insect (three products), powdered insects (two products) or fresh, dried insects (one product). The products thereby represent a variety of insect-based products to be presented in menus for the T5.4 consumer trials. The products are: A ‘minced meat’ product for a Bolognese sauce based on fresh mealworm (*Tenebrio molitor*); A crispy ‘flatbread’ based on cricket powder (*Acheta domestica*); a pre-cooked ‘falafel’ based on fresh buffalo worm larvae (*Alphitobius diaperinus*); a pasteurized sausage based on buffalo worm powder (*Alphitobius diaperinus*); a spiced umami pesto for pasta sauce based on fresh crickets (*Acheta domestica*); and a spicy powder for enriching a legume ‘dahl’ based on fresh, dried and grinded crickets (*Acheta domestica*).

#### 1.1.3 Quality of the products

All products are developed to contain sufficient insect protein to meet the target set for dinner servings (10 g and 13 g insect protein in dinner servings in Portugal and Denmark, respectively). For the sensorial quality, four products were intermediately ad hoc re-evaluated by DTU/Skylab in 2020 to support the improved development. By this report submission, one product has been assessed in a consumer panel at ST, Portugal, and remaining products are scheduled to be assessed by ST latest by April 2021. Two products have been ad hoc assessed for acceptability in school children in Copenhagen.

## 1.2 Status of the work

### 1.2.1 Aim of the report

The objective of WP5 is to develop insect-based food products, validated for sensory profile and consumer perception/acceptance and suited for consumption in dinner meals as a part of regular diets in Europe.

The core work carried out for Deliverable 5.2 is covered by the activities described in task T5.1 (products development) and partially task T5.2 (preparation for product batch production). Activities described as task T5.3 (sensory and acceptability testing) are partially covered and remain to be finalized for all products.

D5.2 builds upon D5.1 in which the outcomes of the workshop held in January 2020 at Skylab/DTU was reported. D5.1 defined the quality criteria for taste, texture, appearance, packaging, labelling, nutritional properties and food safety of the insect-based food products to be tested by consumers. These criteria are the reference for the six project partners involved in insect product development for improving the prototype insect-based products prior to exposure to consumer testing.

Based on the D5.1 report on quality criteria, the food-producing partners continued the product formulation development to reach the final product specifications. This included the development of a production plan for batch production of packed and labelled servings for sensory testing at ST, Portugal (T5.3), and consumer interventions in families in Copenhagen and Portugal (T5.4). However, the March 2020 COVID-19 lockdowns severely impacted the conditions for the involved partners in various ways. Primarily, closed laboratories and experimental kitchens delayed the work required for the practical testing and innovations required to optimize the products. Also, conducting the T5.3 consumer sensory testing by ST in Portugal was not possible in 2020 due to lockdown, and later due to continued restrictions.

For these reasons, the deliverable D5.2 reporting the final specifications and production plans were approved to be rescheduled from M12 (October 2020) to M17 (February 2021). The partners have been able to resume the work planning around the respective national COVID-19 restrictions. By January 2021, the status from the six food-developing partners is that all six products are reported ready for submission for sensory and acceptability test by ST, Portugal. For the improved product specifications, four of the improved products have been re-evaluated by Skylab in 2020, one of which required further improvements. The remaining two products have not been re-evaluated by Skylab after improving the composition.

### 1.2.2 The insect-based dinner products

An overview of the six insect-based products is presented in Table 1. The product specifications are presented in detail in Chapters 2-7. The products represent a variety of food items to be presented in the menus in the T5.4 consumer trials. The products are based on three different insect species, applied in the products as either fresh insect, powdered insects or fresh, dried insects.

**Table 1** Insect-based products names and descriptions

Product	Insect	Portion for 10 g/ 13 g insect protein	Description
Minced Meat	Fresh mealworm ( <i>Tenebrio molitor</i> )	69.4/ 90.3	This textured mealworm-based ingredient can be used as a substitute for ground meat and pairs well with sauces.
Flatbread	Cricket powder ( <i>Acheta domesticus</i> )	82.6/ 107.4	This versatile cricket flatbread can be easily incorporated into one's diet by topping it with other ingredients to be the main dish or complement a meal as the perfect side.
Falafel	Fresh buffalo worm larvae ( <i>Alphitobius diaperinus</i> )	45.0/ 58.0	This Tex-Mex flavoured buffalo worm falafel can be paired nicely with fresh dip/vegetables to form a complete dinner dish. Alternately, it can serve as a side dish or finger food.
Sausage	Buffalo worm powder ( <i>Alphitobius diaperinus</i> )	74.2/ 96.4	This mealworm sausage incorporates insects into a Danish favourite dish.
Umami Pesto	Fresh crickets ( <i>Acheta domesticus</i> )	139.2/ 180.9	This cricket pesto can be added into other sauce to add umami or used to top other foods to add flavour.
Gogga Spice	Fresh, dried and grinded crickets ( <i>Acheta domesticus</i> )	32.0/ 41.6	This mix of spices is incorporated with ground cricket for added protein. It can be used to make dhal or added to enhance the flavour of a variety of other dishes.

### 1.2.3 Nutritional composition of the products

The insect products were developed to meet a target for incorporating insect protein in dinner servings set to replace a minimum of 20% of animal protein in regular diets in Denmark and Portugal in menus to be tested in families (T5.4 activity). The total estimated regular animal protein consumption used to estimate the minimum 20% replacement was defined based on the most recent national consumption survey data in Denmark<sup>1</sup> and Portugal<sup>2</sup>.

In Denmark, the national average of daily intake of meat corresponded to a weekly consumption of 938 g meat, or 187.6 g animal protein (20% protein content in meat). Meat is assumed to be primarily consumed in the lunch and dinner meals, amounting to  $187.6/14 = 13.4$  g animal protein per lunch or dinner meal.

In Portugal, data from a dietary survey in 2015-2016 showed an average meat consumption of 104.4g/adult/d, or 730.8 g meat = 146.2 g animal protein/week (20% protein content in meat). Dividing the meat consumption on lunch and dinner meals, it amounts to 10.4 g animal protein per lunch or dinner meal.

The target for insect protein content in a serving is set to 10 and 13 g insect protein per dinner serving in Portugal and Denmark, respectively. The overall nutritional composition of the products and the meal composition is continuously calculated with the support from UCPH, based on information received from the project partners. The nutritional composition will guide the final meal composition and the guidance of the T5.4 families to how to prepare the weekly menus.

### 1.2.4 Sensory quality and acceptability of the products

#### *Sensory evaluation in Portugal*

Ahead of the home usage testing with the different families in Portugal and Denmark, a structured sensory evaluation was defined between the different producing partners and Sense Test. This activity helps the producing partners to fine tune their formulations, in order to increase the overall acceptability of the products. Different strategies have been designed as depicted in Table 2.

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<sup>1</sup> Dietary habits in Denmark 2011-2013. Main results. Februar 2015. DTU Fødevareinstituttet. Danish Technical University, Lyngby, Denmark. ISBN: 978-87-93109-39-1

<sup>2</sup> Inquérito Alimentar Nacional e de Atividade Física, IAN-AF 2015-2016: Relatório de resultados. Lopes C et al. Universidade do Porto, Portugal. ISBN: 978-989-746-181-1. IAN-AF 2015-2016 ([www.ian-af.up.pt](http://www.ian-af.up.pt))

**Table 2** Summary of the sensory testing planned and conducted activities at Sense Test (ST)

<b>Product (Partner)</b>	<b>Date received or expected at ST</b>	<b>Consumer test plan</b>
Minced meat (KUL)	Not known	Evaluation of overall liking for a single formulation with pasta and a minced meat-analogue mealworm tomato paste, using 100 consumers
Sausage (LEITAT)	Received 04 Feb 2021	Overall liking and open comments for sausages containing lesser mealworm flour, following two preparations: boiled and grilled, using app.60 consumers. Data included in this report will allow LEITAT to improve their product. A second evaluation test is expected for March/April.
Flatbread (UNIVPM)	Received 09 Feb 2021	Overall liking and sensory profiling using Check-All-That-Apply (CATA) ballot of seven different formulations of flatbread with cricket flour and different herbs, using 100 consumers. CATA ballot has already been designed and the sensory evaluation is expected to occur in March, after clearance from the microbial analysis.
Falafel (NGN)	Not known	Not known
Pesto (BD)	Expected March 2021	Overall liking and open comments of two formulations of cricket/tomato umami paste, under two different presentation modes: as a topping over cooked pasta and as a spread on bread or toast, using 100 consumers. The sensory evaluation is expected to occur in April, after clearance from the microbial analysis.
Cricket spicy mix (DTU)	Received 17 Feb 2021	Overall liking and open comments of a cricket spicy flour mix for legume dish, Indian style (dal), using 100 consumers. The sensory evaluation is expected to occur in March, after clearance from the microbial analysis.

### *Acceptability assessment of products in Denmark*

The primary sensory assessment of the products, including a sensory profiling, is conducted by partner Sense Test (ST) in a consumer panel in Portugal. Based on the T5.1 workshop, it was decided to conduct simple acceptability tests in Danish consumers to complement the ST assessments prior to the T5.4 exposure to Danish families. The acceptability testing is based on a 5 step hedonic scale<sup>3</sup> evaluation, documented to be applicable to children. The cut-off for acceptability is pre-determined to be: minimal 50% of the respondents do not dislike the product. It is recognized that the overall liking at the first exposure to unfamiliar products is modest, and the overall liking of novel products are expected to increase by repeated exposures<sup>4,5</sup>.

The acceptability test in Copenhagen was initially planned to be conducted among university students and in public events such as food festivals. Due to the COVID-19 lockdown, the testing was rescheduled to target school classes by linking to educational sessions on sustainable food choices. One product (pesto by partner BD) was pre-tested among 13 school children in an on-site session late 2020. Following COVID-19 school closure in 2021, the test plans were rescheduled again. One product (UNIVMP flatbread) has by February 2021 been tested in online teaching sessions in school children by sending samples to the children at home and conduct a supervised online taste session.

#### **1.2.5 Batch production for T5.4 consumer trials**

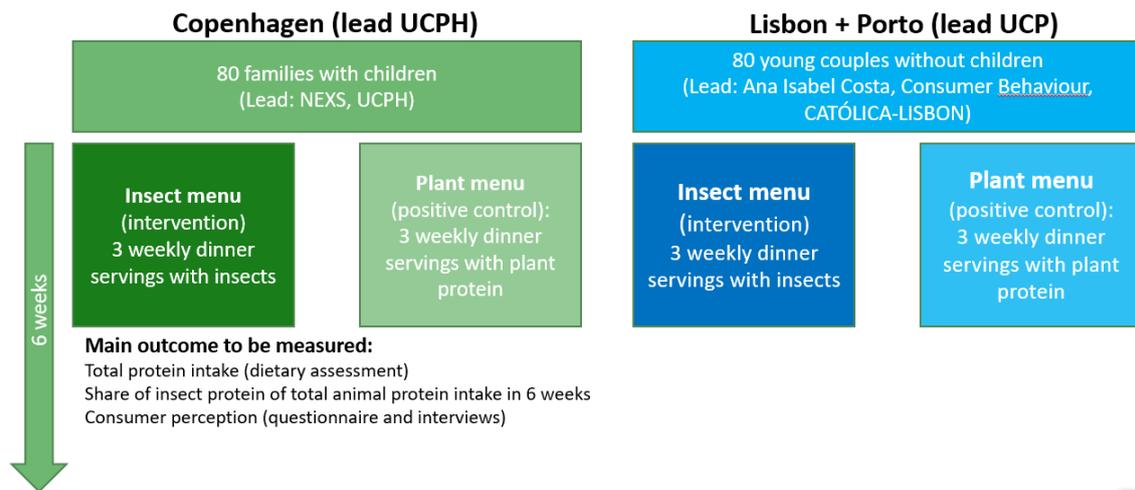
The food products are to be produced in 240 family servings per product, half for Portugal and half for Copenhagen, amounting to the total delivery of 1440 family dinner servings. The servings are family portions to meet the insect protein target. Figure 1 shows the overall intervention design.

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<sup>3</sup> Guinard, J. X. (2000). Sensory and consumer testing with children. *Trends in Food Science and Technology*, 11(8), 273–283. [https://doi.org/10.1016/S0924-2244\(01\)00015-2](https://doi.org/10.1016/S0924-2244(01)00015-2)

<sup>4</sup> Hausner, H., Hartvig, D.L., Reinbach, H.C., Wendin, K. and Bredie, W.L.P., 2012. Effects of repeated exposure on acceptance of initially disliked and liked Nordic snack bars in 9-11 year-old children. *Clinical Nutrition* 31(1): 137-143.

<sup>5</sup> Homann, A. M. M., Ayieko, M. A. A., Konyole, S. O. O., & Roos, N. (2017). Acceptability of biscuits containing 10% cricket (*Acheta domesticus*) compared to milk biscuits among 5-10-year-old Kenyan schoolchildren. *Journal of Insects as Food and Feed*, 3(2), 95–103. <https://doi.org/10.3920/JIFF2016.0054>



**Figure 1** Overview of the T5.4 intervention design.

Note to Figure 1: The consumer intervention is designed to assess the uptake of insect-based dinner products by combining the 6 insect-products in menus of three weekly dinner servings over 6 weeks per participating family

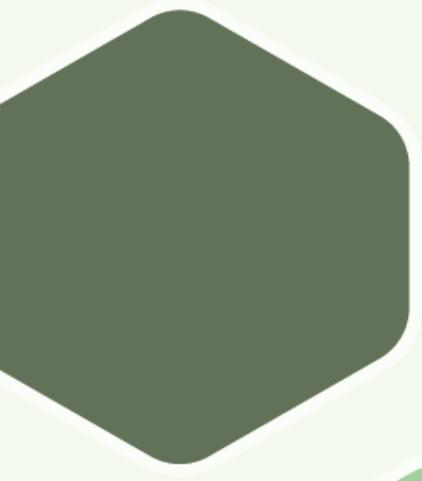
### 1.2.6 Safety assessment of the batch production

Each product will be produced following all necessary steps to assure food safety following practices for GMP (Good Manufacturing Practices) and HACCP (Hazard Analysis and Critical Control Points)-controlled facilities. All transports and storage will use temperature control. Microbiological analyses will be performed upon arrival at Portugal or Denmark prior to the consumer trials. The microbial test plan is described in detail in D10.4.

Process	Hazard Analysis (HA)	Critical Control Points (CCP)	Record Keeping
<b>Ingredients</b> - Buying - Delivery - Storage	Spoilage of ingredients due to unsuitable conditions during transport/storage	<b>Entry check</b> - Visual check - Temperature of transport - Best before date	- Product sheet from supplier - Commercial document incl. batch number
Grinding & mixing ingredients	Contamination with micro-organisms from unhygienic materials	- Prevent cross-contamination - Use clean equipment	Product recipe
Heating	Survival of micro-organisms due to inadequate heating	<b>Cook thoroughly</b> Time x Temperature	Log system (computer/paper) or picture
Cooling	Growth of micro-organisms due to slow chilling	<b>Chill rapidly</b> Time x Temperature	Log system (computer/paper) or picture
Packaging	Contamination with micro-organisms and/or physical contaminants	<b>Personal hygiene</b>	Product label (incl. batch number) & user instructions
Storage	Growth of micro-organisms due to unsuitable conditions	<b>Temperature during storage</b>	Stock & temperature logging
Delivery to client	Growth of micro-organisms due to unsuitable conditions	<b>Temperature during transport</b>	Commercial document incl. batch number

**Figure 2** Overview of a generalizable HACCP plan for insect products.

Note to Figure 2: The HACCP plan is developed and implemented by SUSINCHAIN partner NGN for insect products, and shared as the general standard for insect-based food products.



## **CHAPTER 2**

**`Minced Meat` by KUL**

## Chapter 2 – Minced meat (KUL)

### 2.1 Product Specification

#### 2.1.1 Composition

A mealworm-based minced meat product was developed and improved based on the T5.1 workshop feedback of an early prototype<sup>6</sup>. The minced meat is prepared by blanching, grinding and stir-frying fresh mealworms (*Tenebrio molitor*) and with addition of a binding agent and spices to create minced meat texture and flavour. The minced meat will be included in a spaghetti bolognese-type tomato sauce that can be added to pasta. Figure 3 shows the mealworm mince (bottom) and the mealworm mince in a tomato sauce.



**Figure 3** ‘Minced meat’ (bottom) and inclusion in a tomato sauce (top)

#### 2.1.2 Insect component of the product

The insects used in the insect minced meat are mealworms (*Tenebrio molitor*). Mealworms are used in their final larval instar, after sieving them from their substrate. Mealworms are transported alive and refrigerated to the production facility, where they will be killed by blanching. Approximately 81 g mealworms is included to produce 100 g insect minced meat, resulting in approximately 14.4 g mealworm proteins per 100 g insect minced meat.

The insects are obtained from the insect rearer, NuSect, in Deerlijk, Belgium. Mealworms are reared specifically for human consumption. NuSect has obtained permissions as “insect rearer,” “food retailer,” and “producer, processor and trader of foodstuffs” granted by the Belgian Federal Agency for the Safety of the Food Chain (FASFC<sup>7</sup>).

<sup>6</sup> Stoops, J., Vandeweyer, D., Crauwels, S., Verreth, C., Boeckx, H., Van Der Borgh, M., et al. (2017). Minced meat-like products from mealworm larvae (*Tenebrio molitor* and *Alphitobius diaperinus*): microbial dynamics during production and storage. *Innovative Food Science & Emerging Technologies*, 41, 1–9.

<sup>7</sup> Foodweb is an official website of the Belgian Government and belongs to the FASFC. <https://www.foodweb.be/operator/Public/ViewOperator.aspx?id=4393571>

### 2.1.3 Other ingredients

Other ingredients include those used in the bolognaise sauce, which are olive oil, carrot, white onion, garlic, red bell pepper, zucchini, white mushrooms, canned tomato cubes (Elvea), spaghetti herbs (Boni Bio), and water.

### 2.1.4 Product composition

The ingredients used and nutritional composition for the minced meat product is shown in Table 3 and

Table 4.

**Table 3** Ingredients used to prepare 100g of minced meat before processing

Ingredient	Quantity (g)
Mealworms	56.85
Potato Starch	0.57
Salt (table)	0.85
White Pepper	0.45
Freeze Dried Onions	0.45
Nutmeg	0.34
Paprika Powder	0.68
Egg white powder	7.39
Water	29.56
Arachid oil	2.84
<b>TOTAL</b>	<b>100.00</b>

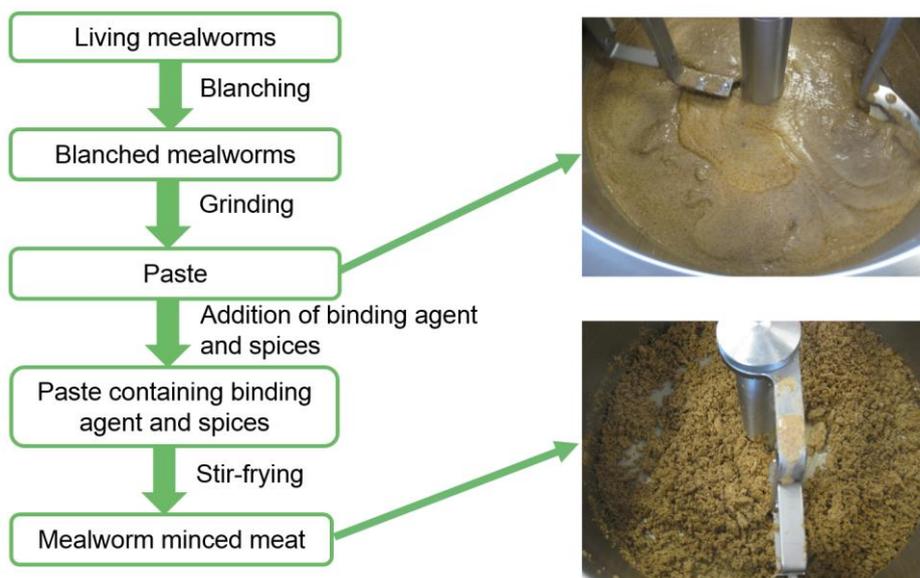
**Table 4** Nutritional composition and energy of 100 g minced meat

Nutrition Fact	Quantity (per 100g)
Energy (kcal)	265.74
Energy (kJ)	1114.48
Fat (g)	14.04
Saturated Fat (g)	3.17
Carbohydrates (g)	7.96
Sugar (g)	0.34
Total Protein (g)	23.34
Insect Protein (g)	14.40
Sodium (mg)	638.05
Dietary Fibre (g)	214.50

## 2.2 Production

### 2.2.1 Processing of the product

Figure 2 schematically explains the production process. Furthermore, live mealworms are blanched by steaming for 5 minutes at 100 °C. In order to obtain a product that has a good “mouthfeel”, and thus a complete absence of fine exoskeleton particles, a thorough grinding process is necessary. After a 25-minute two-step grinding process in a bowl cutter and subsequently a micro cutter, a liquid paste is obtained, which becomes more viscous after a few minutes stored in the refrigerator. After grinding, the spices and the resuspended egg white powder are added. The mixture is homogenised in the bowl cutter. In the next step, the liquid mixture is stir-fried (12 rpm) at 100 °C for 15 minutes in peanut oil. During this frying step, the liquid semi-finished product thickens and obtains its minced meat-like texture.



**Figure 4** Overview of the mealworm minced meat production process

### 2.2.2 Serving of the product

The mealworm minced meat is proposed to be served in a bolognese-type pasta sauce, accompanied by the consumer’s choice of pasta. For each serving, mealworm minced meat and sauce will be provided separately. The consumer can add both parts together, reheat the final sauce with insect minced meat (simmer for 10 minutes), and serve the sauce with cooked pasta.

The bolognese-type sauce is prepared by frying all the cleaned and chopped vegetables together with the herbs, adding canned tomatoes and water, and simmering for 20 minutes.

According to the requirements of 10 g and 13 g insect proteins per serving for Portuguese and Danish households, respectively, servings of 69.4 and 90.3 g are proposed for consumer trials in Portugal and Denmark.

### 2.2.3 Packaging

Both the insect minced meat and the sauce are packed in air in food-grade plastic bags (PA/EVOH/PA/PE, Euralpack, Belgium) and sealed (Figure 3). Immediately after production, both products are packed and frozen at -20 °C.



**Figure 5** Mealworm minced meat packed in plastic bags

## 2.4 Batch production for T5.4 consumer trials

### 2.4.1 Production location

Batch production of the mealworm minced meat will take place at the pilot facility of the research group for Technology and Quality of Animal Products (KU Leuven Technology Campus Ghent, Belgium). This pilot facility is equipped with the necessary large-scale cutters, fryers, and freezers to professionally produce the insect product. Good hygienic practices will be applied during the production of the mealworm mince.

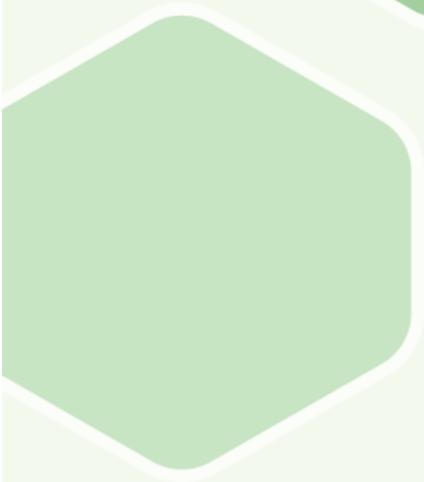
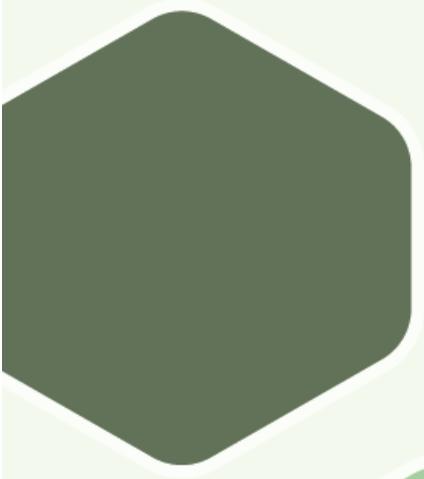
The bolognaise-type sauce will be produced in a demonstration kitchen at Lab4Food (KU Leuven Campus Geel, Belgium).

### 2.4.2 Product production

The large-scale production of the products will follow the same protocol as described above (“Product production”). Depending on the capacity of the equipment, the servings for the T5.4 trials will be produced in one or a few batches.

### 2.4.3 Packaging, storage and shipment

After production, the mealworm minced meat and the sauce will be packed and frozen at -20 °C. The products can be stored in a domestic freezer at -20 °C and transported on dry ice.



# **CHAPTER 3**

**Cricket Flatbread (UNIVPM)**

## Chapter 3 - Cricket flatbread (UNIVPM)

### 3.1 Product specification

#### 3.1.1 Composition

The flatbread is made with soft wheat flour, durum wheat flour, insect powder (*Acheta domesticus*), chickpea flour, oat flour, barley malt, salt baker’s yeast, and water thoroughly rolled into flattened dough. Usually, the thickness of flatbreads range from below one millimetre to a few millimetres so that they can be easily eaten without being sliced. Flatbread can usually be baked in an oven and eaten fresh or packaged for later use.

#### 3.1.2 Insect component of the product

The insect component of the flat bread is powdered crickets (*Acheta domesticus*) produced by Nutr insect, located in via Enrico Mattei, 65, 62010 Montecassiano, MC, Italy.

#### 3.1.3 Other ingredients

Other ingredients of the dinner meal will vary in accordance with the consumer’s preferred way of eating flatbread. In the composition of the weekly menus for the T5.4 consumer intervention, the flatbread will be incorporated as an complementary food in the dinner meals, and also indicated to be consumed at lunch.

#### 3.1.3 Product composition

The ingredients used and nutritional composition for the flatbread product is shown in Table 5 and Table 6.

**Table 5** Ingredients used to prepare 100g of flatbread before processing

Ingredient	Quantity (g)
Soft wheat flour	30.03
Durum flour	12.87
Insect powder	13.20
Chickpea flour	5.28
Oat flour	3.30
Barley malt	1.32
Salt	0.66
Baker's Yeast	0.33
Water	33.00
<b>TOTAL</b>	<b>100.00</b>

**Table 6** Nutritional composition and energy of 100 g flatbread

Nutrition Fact	Quantity (per 100g)
Energy (kcal)	236.80
Energy (kJ)	994.71
Fat (g)	3.77
Saturated Fat (g)	0.90
Carbohydrates (g)	37.95
Sugar (g)	0.92
Total Protein (g)	15.03
Insect Protein (g)	8.11
Sodium (mg)	258.81
Dietary Fibre (g)	4.25

### 3.1.4 Sensory assessment

#### *Sensory profiling in Portugal*

Overall liking and sensory profiling using Check-All-That-Apply (CATA) ballot of seven different formulations of flatbread with cricket flour and different herbs, using 100 consumers. CATA ballot has already been designed and the sensory evaluation is expected to occur in March, after clearance from the microbial analysis.



**Figure 6** Flatbread with 20 % cricket flour and different herbs: basil; fennel seeds; chives; sage; rosemary and oregano.

Samples have been sent to ST and from a preliminary evaluation session with the sensory team, a list of attributes was drawn to include in the Check-All-That-Apply (CATA) ballot (see Table 7) to be used for sensory profiling of the different flatbreads, after clearance from microbial analysis.

**Table 7** List of sensory attributes for the sensory profiling of flatbread with cricket

Sensory dimension	Attribute
Appearance (4)	Dark colour; light colour; toasted; appealing
Smell (5)	Toasted; aromatic herbs; earthy; cereals; like pet food
Texture (5)	Dry; hard; soft; crispy; crunchy; floury/sandy
Flavour/taste (12)	Salty; anise; nutty; tasty; bland; toasted; aromatic herbs; cereals; earthy; rancid; spices; musk

Note to Table 7: The list of sensory attributes, organized by sensory dimension, is to be included in the CATA ballot for the sensory profiling of flatbread with cricket flour and herbs

### *Acceptability testing in Denmark*

During COVID-19 lockdown of schools, it was possible to include the acceptability assessment to online teaching sessions assigned to Bugging Denmark by schools in the Copenhagen municipality. By the submission date, 56 school children have assessed the plain version of the flatbread in supervised online sessions using the 5 step hedonic scale<sup>8</sup>. The overall liking of the bread was assessed in this group of children to be 3 or above by 34 of the 56 children (62%). The acceptability cut-off was pre-determined to minimum 50% assessing the overall liking to be 3 or above (see 1.2.4 Sensory quality and acceptability of the products).

## 3.2 Production

### 3.2.1 Processing of the product

All ingredients are mixed in a professional spiral kneading machine for approximately 10 minutes. The kneaded dough are left leavening at 25 °C for 60 minutes. Kneaded pieces of around 125 g are smoothed to a height of about 1-2 mm and formed into the flatbread using a knife. The prototypes were formed in small squares of approximately 3 cm x 3 cm size. A fork was used to make small holes and bread was lightly sprinkled with salt. Flat bread was oven cooked at 240 °C for about 5 minutes. Flavoured varieties are currently being tested.

### 3.2.2 Serving of the product

Flatbread can be consumed fresh soon after baking or stored for 1-2 months. The bread has very low water activity.

<sup>8</sup> Guinard, J. X. (2000). Sensory and consumer testing with children. *Trends in Food Science and Technology*, 11(8), 273–283. [https://doi.org/10.1016/S0924-2244\(01\)00015-2](https://doi.org/10.1016/S0924-2244(01)00015-2)

### 3.2.3 Packaging

Flatbread can be packaged in single servings using sealed food-grade plastic bags and shipped at room temperature.

## 3.3 Batch production for T5.4 consumer trials

### 3.3.1 Production location

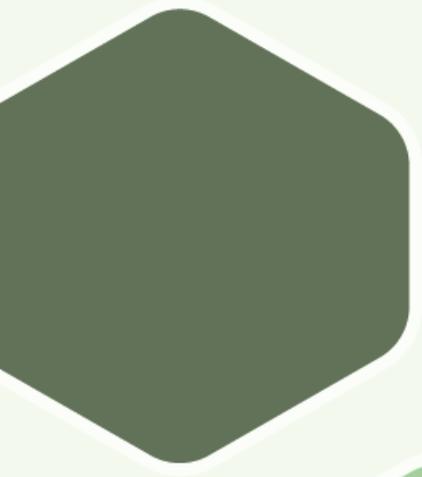
Prototypes were produced at the laboratory of Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, UNIVPM, via Breccie Bianche, 60131, Ancona, Italy. A larger-scale production location is currently being identified for the T5.4 batch production.

### 3.3.2 Product production

The flatbread will be produced in serving sizes required for the family interventions. Currently, different flavours are tested in the sensory assessment by ST. The batch product is flexible and can produce a combination of different flavours.

### 3.3.3 Packaging, storage and shipment

Flatbread can be packaged in single servings using sealed food-grade plastic bags and shipped at room temperature due to the long shelf-life consequent to low water activity.



# CHAPTER 4

Falafel (NGN)

## Chapter 4 – Falafel (NGN)

### 4.1 Product specification

#### 4.1.1 Composition

The falafel pieces are patty and/or ball-shaped (Figure 7), have an approximate mass of 25 g and are approximately 2 cm in diameter.



**Figure 7** Buffalo worm falafel ball.

The falafel consists of three parts: the core, a batter and coating. The core principally consists of hydrated uncooked chickpeas (47%). Buffalo worms make up approximately 38% of the core's mass. The residual mass is supplied by a ragout, a binder, and seasonings. The core is coated in a maize flour batter and ground cornflakes.

The product is ready for the sensory testing (T5.3) and consumer testing (T5.4) in the present formulation. We aspire to improve the falafel by substituting the palm oil in the batter with a more sustainable option derived from Europe. FI & S will be employed to improve the properties of the falafel emulsifying / binding system.

#### 4.1.2 Insect component of the product

All legal obligations regarding novel food application are met by Kreca/Protifarm by submitting a novel food application at EFSA (Proti-Farm Holding NV, 2018)<sup>9</sup>.

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<sup>9</sup> Proti-Farm Holding NV. (2018). Summary of the dossier: whole and grinded *Alphitobius diaperinus* larvae products. [https://ec.europa.eu/food/sites/food/files/safety/docs/novel-food\\_sum\\_ongoing-app\\_2018-0125.pdf](https://ec.europa.eu/food/sites/food/files/safety/docs/novel-food_sum_ongoing-app_2018-0125.pdf)

Food grade buffalo worm larvae (*Alphitobius diaperinus*) are sourced from Protifarm’s Kreca Ento-Food B.V. (Ermelo, The Netherlands). Good Manufacturing Practices (GMP) + feeds and side streams such as brewers’ grains serve as substrates. ‘Slaughtering’ of the insects is preformed via blanching, consequently reducing surface contamination, and preventing enzymatic discolouration/rancidity. Lastly, the larvae are packaged in (blue) food grade sealed plastic bags and frozen (-18°C) until further use.

### 4.1.3 Other ingredients

The chickpeas supplier has not yet been identified. Various suppliers (maza, multiflour & MPF) are currently in review. Structural integrity and water retention are maintained with the aid of carboxymethylcellulose (E466), complimentary to the emulsifying properties of the chickpeas. The CMC is supplied by FI & S B.V. (Maastricht, The Netherlands). Wheat flour is used in a ragout and the batter and is supplied by Royal Avebe U.A., Veendam, and The Netherlands. Seasonings have been bought from Verstegen Spices & Sauces B.V. (Rotterdam, The Netherlands), who steam treat their products to inactivate spore-forming bacteria.

### 4.1.4 Product composition

The ingredients used and nutritional composition for the falafel product is shown in Table 5 and Table 6

**Table 8** Ingredients used to prepare 100g of falafel before processing

Ingredient*
Chickpeas, hydrated
Buffalo worms ( <i>Alphitobius diaperinus</i> )
Ragout
Coating
Batter
Seasoning 1
Seasoning 2
Carboxymethylcellulose E466

\* Quantities non-disclosed for publication

**Table 9** Nutritional composition and energy of 100 g falafel

<b>Nutrition Fact</b>	<b>Quantity (per 100g)</b>
Energy (kcal)	451
Energy (kJ)	1899
Fat (g)	12.6
Saturated Fat (g)	4.2
Carbohydrates (g)	51.8
Sugar (g)	5.1
Total Protein (g)	29.7
Insect Protein (g)	22.2
Sodium (mg)	1.6
Dietary Fibre (g)	7.5

### 4.1.5 Sensory assessment

#### *Pre-testing in The Netherlands*

A non-trained panel consisting of employees from different companies/institutions (Sligro, Appel, Ruig and WUR) was utilized to pre-assess the sensory quality of the falafel. The general census that came forth out of a sensory evaluation was that the product is saturating, novel, tasty but somewhat to salty. The product is prepared to be shipped for sensory testing at ST, Portugal.

## 4.2 Production

### 4.2.1 Processing of the product

Practical aspects of the preparation procedure are laid down under 4.3.2 Product production.

The falafel consists of three parts: the core, a batter and coating. In preparation to the production of the product, chickpeas need to be hydrated. A ragout is prepared in a kettle under continuous agitation. After cooling, larvae are minified in a meat grinder. Hydrated chickpeas are minified and combined with the larvae, ragout, seasonings, and emulsifier in the same bowl cutter. The acquired dough needs to rest at cooled conditions. The batter is applied to portion with a machine press dough balls (20 g). Consecutively, a coating is applied.

The balls are deep fried and frozen via shock freezing. Lastly, the products are packaged and stored in a freezer.

### 4.2.2 Serving of the product

The recommended portion size is 100 grams (5 balls). The falafel needs to be stored in the freezer (-18°C) until prepared for serving. The consumer is tasted with finishing the product by either:

1. Deep-frying for 4.5 minutes at 180°C,
2. Oven baking for 12 minutes at 180°C or
3. Pan frying for 9 minutes at middle-high heat.

### 4.2.3 Packaging

Storage and shipping should take place at -18°C. No packaging specifications have been defined as of this moment.

## 4.3 Batch production for T5.4 consumer trials

### 4.3.1 Production location

The batch will be produce at M. Ruig en zonen B.V. (Oostzaan, The Netherlands). This production facility is BRC (British Retail Consortium) certified.

### 4.3.2 Product production

Production is spread over three consecutive days.

Day 1:

1. The chickpeas are soaked in water for a minimum of 12 hours at 4°C.
2. Excess water is removed after soaking.

Day 2: Ragout preparation

1. 160% of the required ragout is prepared as evaporation has proven to diminish approximately 50% of the ragout's mass.
2. Heat the oil in a pan to 60°C.
3. Add the wheat flour while stirring.
4. Stir until the wheat flour is cooked.
5. Add water while stirring and heat up to 100°C.
6. Stir at 100°C until all the water is bound.
7. Cool to 4°C.
8. Minify the chickpeas in batches of 40 kg for 1 minute in a bowl cutter on speed "2".
9. Buffalo worms are minified with poulet plate 3 mm in a meat grinder.
10. Buffalo worms, herbs, emulsifier, and ragout are added to the cutter and mixed.
11. Let the dough rest for 12 hours in the refrigerator at a maximum of 4°C.

Day 3:

1. Portion and form dough balls.
2. Coat with batter and crushed cornflakes with a paneer line.
3. Pre-frying (temperature 160°C, belt 1: position 4, belt 2: position 1.5).
4. After frying the product is frozen in a shock freezer.
5. Package frozen falafel.

Conformity to HACCP prerequisite programs are assured via the inhouse quality system of M. Ruig en zonen B.V. Additionally, this production location is BRC certified. The microbiological composition of the falafel has experimentally been investigated during development on the following (groups of) microbes: Aerobic mesophilic colony-forming units, *Enterobacteriaceae*, Lactic acid bacteria, Yeasts and moulds, *Pseudomonas* spp., Mesophilic and thermophilic spore forming microbes, *Clostridium perfringens*, *Salmonella* spp. (25 g), *Listeria monocytogenes* (25 g). No pathogens were found.

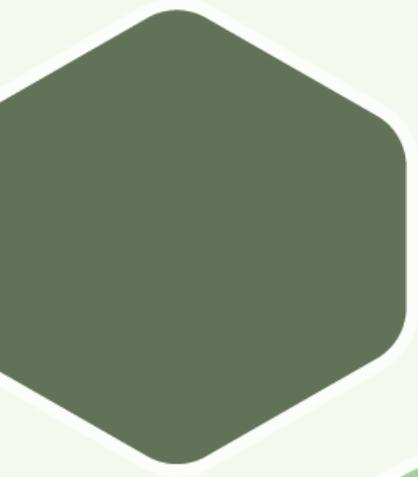
Acceptable quantities ( $4.8 \cdot 10^2$  cfu/g) of aerobic mesophiles were found. Appreciable quantities ( $4.6 \cdot 10^2$  cfu/g) of mesophilic spore-forming bacteria were found. It is unknown whether this group consists of pathogenic or spoilage bacteria. Out of precaution, the cold chain during transportation and storage should not be broken. A microbiological investigation into the buffalo worm concluded that blanched frozen larvae carry a lower microbial load than fresh or freeze-dried larvae. This is in line with the findings of Vandeweyer (2018)<sup>10</sup>. The larvae are heated twice during processing. The specified heating time/temperature combinations serve as the minimum tolerance levels. The falafel is conform the requirements of Dutch product safety authority (NVWA) concerning insect containing foods.

### 4.3.3 Packaging, storage and shipment

Storage and shipment will be at -18°C.

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<sup>10</sup> Vandeweyer, D. 2018. Microbiological quality of raw edible insects and impact of processing and preservation. Mol: Dries Vandeweyer. Dissertation presented in partial fulfilment of the requirements for the degree of Doctor of Engineering Technology (PhD)



# **CHAPTER 5**

**Mealworm Sausage (LEITAT)**

## Chapter 5 – Buffalo sausage (LEITAT)

### 5.1 Product specification

#### 5.1.1 Composition

The sausages prototypes (Figure 8) are made with defatted lesser mealworm protein flour (*Alphitobius diaperinus*) at 20.75%. The rest of the ingredients on the formula are the following: 55% water, 3% salt, 3% olive oil and 18.25% of the rest ingredients necessary for making a good sausage paste (stabilizers, emulsifiers, flavourings). The final composition of the sausage relies of the acceptability and sensory testing undertaken in February 2021. Previous pre- assessment of prototypes have resulted in an unacceptable bitter taste originating from the buffalo worms.

In the final composition, the sausages will be presented at the consumers as shown in the image 1, vacuum-packaged with 3 sausages per package. The total amount of 1 sausage is 100 g.



**Figure 8** Mealworm sausage prototypes

#### 5.1.2 Insect component of the product

The insect powders used in the formula were obtained from the company Protifarm. The whole buffalo powder (*Alphitobius diaperinus*) is light brown in colour and has a nutty taste. The protein content is declared to 59.6g /100g. The insect protein concentrate (*Alphitobius diaperinus*) is a beige/off white colour and has a savoury flavour. The protein content is declared to 58.5 g/ 100g.



**Figure 9** Insect powders used for the production of mealworm sausage

### 5.1.3 Other ingredients

The other ingredients utilized in the formula are:

- Water: Necessary for binding and moisturizing the formula
- Oil: Binding, emulsifying properties, taste
- Stabilizers: For food safety
- Emulsifiers: Emulsifying agent
- Salt and aroma: As flavour enhancers

### 5.1.4 Product composition

The ingredients used and nutritional composition for the sausage product is shown in Table 10 and Table 11.

**Table 10** Ingredients used to prepare 100g of buffalo mealworm sausage before processing. The composition will be adjusted based on sensory profiling

Ingredient	Quantity (g)
Defatted Powder	20.75
Olive Oil	3.00
Salt	3.00
Water	55.00
Other	18.25
<b>TOTAL</b>	<b>100.00</b>

**Table 11** Nutritional composition and energy of 100 g buffalo mealworm sausage

Nutrition Fact	Quantity (per 100g)
Energy (kcal)	133.41
Energy (kJ)	556.06
Fat (g)	8.19
Saturated Fat (g)	2.21
Carbohydrates (g)	1.80
Sugar (g)	0.33
Total Protein (g)	12.23
Insect Protein (g)	13.48
Sodium (mg)	1661.54
Dietary Fibre (g)	0.32

### 5.1.5 Sensory Assessment

A batch of 40 sausages containing lesser mealworm flour was sent by LEITAT to ST, frozen and packed under vacuum (see Figure 10). Samples have been cleared by microbial analysis and a sensory assessment including overall liking (on a classic 9-point hedonic scale) and open comments.



**Figure 10** Frozen vacuum-packed sausages (Buffalo sausages)

Samples were thaw under refrigeration one day ahead of the evaluation. To have a better insight on the product performance, sausages were tested boiled (immersed for 5 minutes in hot water) or grilled (grooved plate grill greased with vegetable oil). Due to the size of the sausages, serving sizes were reduced to one third of the sausage, enabling to enlarge the evaluation to 60 consumers. All participants were selected based on their willingness to try products containing edible insects, after informed consent.

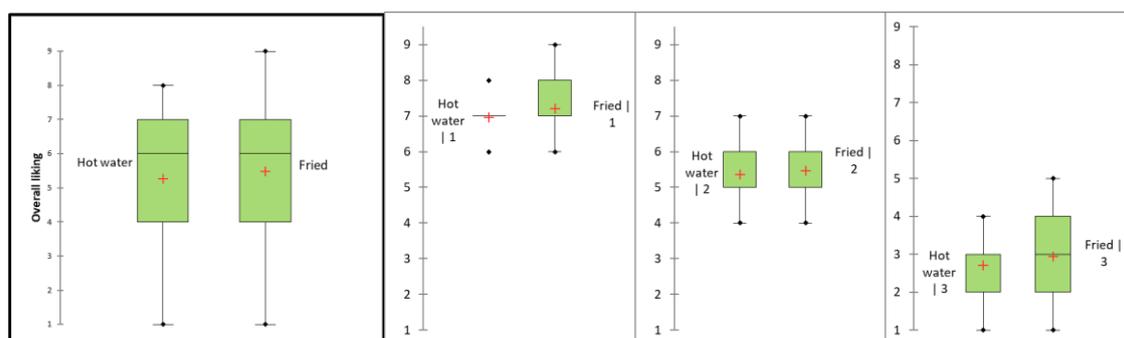
Samples were presented coded on white porcelain plates (see Figure #), following a sequential monadic presentation order. Participants were instructed chew a small bit of a bland cracker and to rinse their mouth with water, before each evaluation.



**Figure 11** Sample preparation and presentation for sensory evaluation.

Note to Figure 11: A: Warmed sausage; B: Grilled sausage; C: sausage serving; D: Warmed sausage; E: Grilled sausage (sample code 315)

No significant differences were found ( $p > 0.05$ ) on the overall acceptance of samples from both preparations, with consumers' evaluations presenting a very high variation, spanning the full scale. Following clustering analysis, based on the overall liking scores given to both samples, it was possible to segregate the participants into 3 groups (see Figure 12).



**Figure 12** Distribution of the overall liking scores for both samples of Buffalo sausages.

Note to Figure 12: Left side, full sample ( $n=59$ ), right side, Cluster 1 ( $n=25$ ); Cluster 2 ( $n=17$ ) and Cluster 3 ( $n=17$ )

Approximately 36% of the participants have negatively evaluated the samples (overall liking  $< 6$ ).

From the analysis of the open comments, after content analysis, no significant differences emerge between samples, except for 'dark colour' appearance, mostly penalising the grilled samples. The sausages warmed in hot water tend to

present more positive attributes and less negative attributes than the grilled ones (see Table #). In general, there is a large count of negative attributes, namely, ‘unpleasant’ texture and ‘bitter’ and ‘intense’ taste.

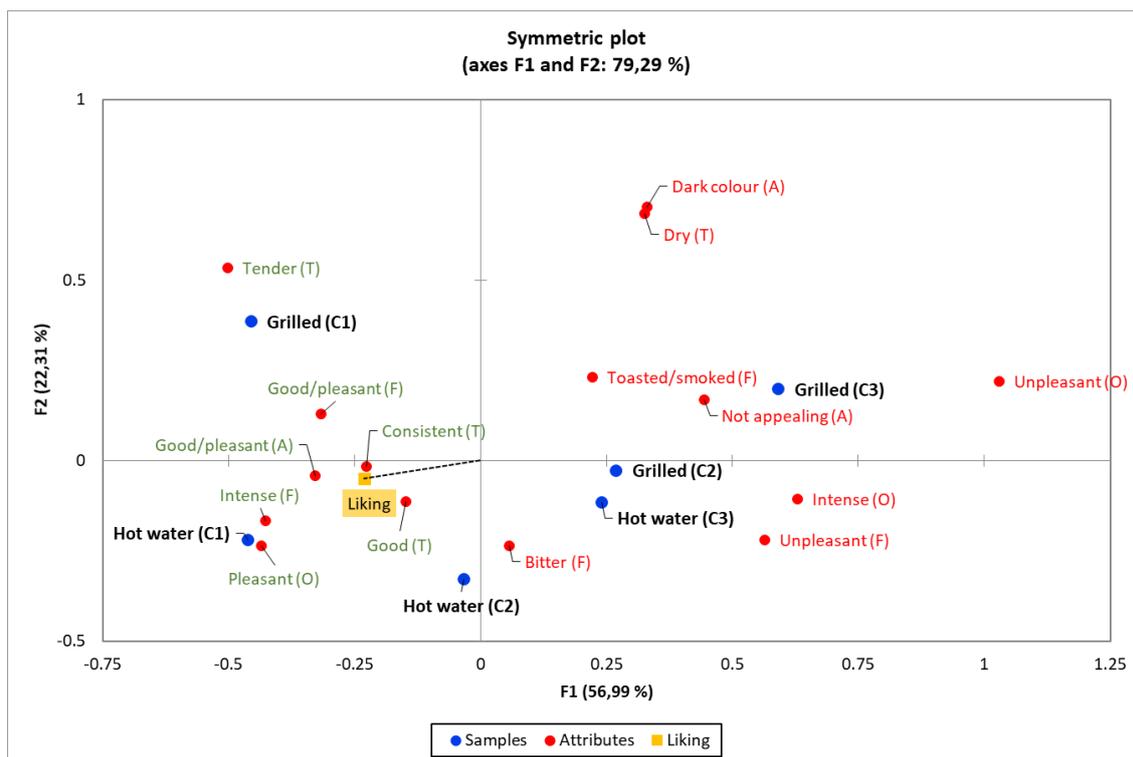
A list of major positive and negative attributes associated to the buffalo sausages (warmed and grilled), resulting from the content analysis of the open comments is shown in Table 12.

**Table 12** List of major positive and negative attributes associated to the buffalo sausages

	Attributes	Hot water	Grilled
<b>Positive</b>	Good/pleasant (A)	23	18
	Good (T)	22	16
	Good/pleasant (F)	15	17
	Consistent (T)	8	6
	Tender (T)	5	9
	Pleasant (O)	6	3
	<b>Total +</b>	<b>94</b>	<b>82</b>
<b>Negative</b>	Unpleasant (F)	21	19
	Bitter (F)	19	18
	Intense (F)	13	10
	Toasted/smoked (F)	5	10
	Not appealing (A)	5	9
	Dark colour (A)	1 (-)	8 (+)
	Unpleasant (O)	2	7
	Intense (O)	4	3
	Dry (T)	1	5
	<b>Total -</b>	<b>84</b>	<b>102</b>

Note to Table 12: The attributes of warmed and grilled sausages resulting from the content analysis of the open comments. (A) Appearance; (O) Odour; (T) Texture; (F) Flavour/taste. (-)/(+) represent significant differences, according to the Fisher exact test, by cell ( $p < 0.05$ ).

The comparison of the open comments, in accordance with the clustering of the participants sheds additional light into the rejection of the buffalo sausages, as depicted in the Correspondence Analysis bi-plot presented in Figure 13.



**Figure 13** Correspondence Analysis bi-plot, based on the open comments attributes count.

Note to Figure 13: Positive in green, negative in red. Plot segregates samples in accordance to the consumers' segment (C1 – acceptors; C2 – slight rejecters; C3 – strong rejecters). Overall liking was plotted as a supplementary variable. (A) Appearance; (O) Odour; (T) Texture; (F) Flavour/taste.

These data clearly show that rejection of the Buffalo sausages is mainly based in the perception of a 'bitter' and 'unpleasant' taste and an 'intense' and 'unpleasant' aroma that they many were not able to objectively identify.

It is relevant to note that previous research reported in the literature shows that lesser mealworm flour is much more bitter than the one from house crickets or from mealworms.

Data included in this report will allow LEITAT to improve their product. A second evaluation test with reformulated sausages is expected for March/April.

## 5.2 Production

### 5.2.1 Processing of the product

The consumers will have the sausages as presented in Figure 11. They will only have to cook them in a pan and the sausages will be ready to serve.

### 5.2.2 Serving of the product

The consumers can serve insect-based sausages similarly to conventional ones. They can be prepared in countless different recipes adapted for each country, culture, and family's choice.

### 5.2.3 Packaging

The product will contain 3 vacuum-packed sausages, equalling 100 g each per package. The sausages will be shipped frozen and should be maintained the cold chain during distribution. Once the consumers receive the sausages, they can store them in the refrigerator (0- 4 °C) up to one week before consumption. The sausages can also be served raw as it is a pasteurized product, but cooking is recommended for a more favourable taste.

## 5.3 Batch production for T5.4 consumer trials

### 5.3.1 Production location

The production takes place in LEITAT Technological Center food lab, located at Barcelona. The facilities are provided with a kitchen, and food technologies at lab scale.

### 5.3.2 Product production

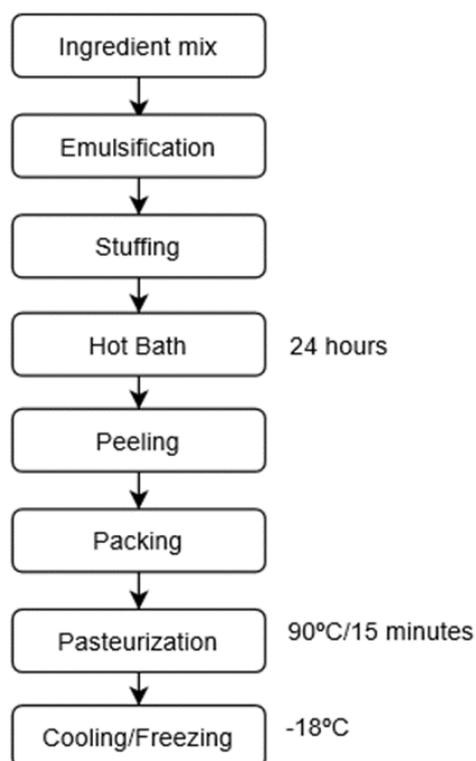
All the equipment used for the sausages production are on tabletop devices and include thermomixer, stuffer, hot bath and vacuum chamber.

The protocol followed is the following:

- Before entering in the kitchen facilities there is a sanitizing and clothing zone where the manufacturer cleanses their hands, wears a lab coat, head cover, shoes cover, mask and gloves.
- The kitchen has proper ventilation.
- The equipment is cleaned under proper cleaning procedures.



Figure 14 Sausage stuffing equipment

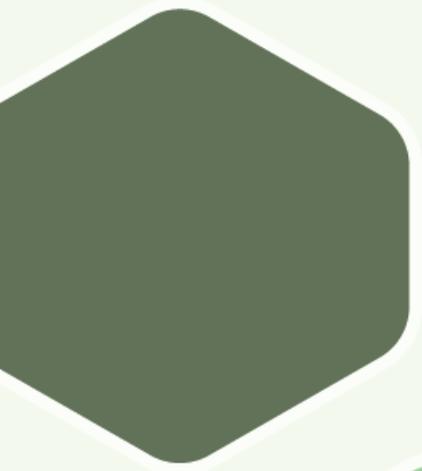


**Figure 15** Production steps for the buffalo mealworm sausage

The sausages are pasteurized and will be prepared in a kitchen facility. A HACCP plan has been developed and ready for implementation.

### 5.3.3 Packaging, storage and shipment

Packaging is done in packages of 5 sausages per bag and is stored at  $-18^{\circ}\text{C}$ . The shipment must be done under frozen condition either a frozen shipment transportation or a box with dry ice delivered within 24h. Once the sausages arrives must be hold under frozen conditions and it's only when the sausages are fully unfrozen the shelf-life, stored between  $0-4^{\circ}\text{C}$ , is of approximatively 15 days.



# **CHAPTER 6**

**Cricket Umami Pesto by BD**

## Chapter 6 – Cricket umami pesto (BD)

### 6.1 Product specification

#### 6.1.1 Composition

The product is a versatile paste, which can be used in many different culinary traditions to contribute with umami flavour. The primary source of umami in the paste is cricket, although it also contains other components rich in umami, such as soy sauce, tomato paste, shiitake mushrooms and anchovies. Other flavours come from the Basque chili spice Pimente D’Espelette, garlic and black pepper, to name a few. Depending on how the paste is used in cooking, it can for instance be used to make:

1. Bolognese with carrot (for texture), extra tomato
2. Thai curry with vegetables, coconut milk, curry paste
3. Mexican tacos with chili, cilantro, more vegetables

Participants in the study will be given recipes to assist them in cooking with the paste in their own homes.

#### 6.1.2 Insect component of the product

The paste contains fresh house crickets (*Acheta domesticus*) which are sourced from a local producer certified for human consumption and transported frozen to the BD production kitchen. One portion with 13 g of cricket protein contains approximately 65 g of crickets.

#### 6.1.3 Other ingredients

Other ingredients may vary depending on consumer preferences. All ingredients will be supplied by a major Danish wholesale supplier to professional kitchens. Product sheets will be acquired for all ingredients.

#### 6.1.4 Product composition

The ingredients used and nutritional composition for the pesto product is shown in

Table 13 and Table 14.

**Table 13** Ingredients used to prepare umami pesto before processing

<b>Ingredient*</b>
Frozen Cricket
Olive Oil
Rapeseed Oil
Tomato Paste
Spices
Shallot
Balsamic Oil
Soy Sauce
Shiitake Mushrooms
Black Pepper

\*Quantities non-disclosed for publication

**Table 14** Nutritional composition and energy of 100 g umami pesto

<b>Nutrition Fact</b>	<b>Quantity (per 100g)</b>
Energy (kcal)	223.85
Energy (kJ)	932.84
Fat (g)	17.41
Saturated Fat (g)	2.39
Carbohydrates (g)	8.37
Sugar (g)	2.95
Total Protein (g)	9.19
Insect Protein (g)	7.18
Sodium (mg)	486.81
Dietary Fibre (g)	2.18

### 6.1.5 Sensory assessment

Due to corona-related restrictions, it has only been possible to perform a limited pilot-scale assessment of the paste on Danish primary school pupils (N=13). The pupils were asked to rank the paste on a 5-step hedonic scale<sup>11</sup> with the two extreme scores indicating a ‘very bad’ and ‘very good’ assessment, respectively, and 2 indicating a bad, 3 indicating a neutral and 4 indicating a good assessment. Results are shown in table 15. The initial results indicate that the product will pass

<sup>11</sup> Guinard, J. X. (2000). Sensory and consumer testing with children. Trends in Food Science and Technology, 11(8), 273–283. [https://doi.org/10.1016/S0924-2244\(01\)00015-2](https://doi.org/10.1016/S0924-2244(01)00015-2)

the accessibility test and may be used in intervention study. The lower score in the texture category may be due to the paste being served as-is, rather than being incorporated in a dish.

**Table 15** Results of pilot-scale sensory assessment

	<b>Average Score (N=13)</b>
<b>Visual impression</b>	3.0
<b>Taste</b>	4.0
<b>Texture</b>	2.8
<b>Overall assessment</b>	3.5

## 6.2 Production

### 6.2.1 Processing of the product

Processing of cricket umami pesto is described as follows:

1. Receiving products. Product integrity is inspected manually and compared to order note. Ingredients are stored under designated conditions until production. Crickets are stored at -20° Celsius.
2. All ingredients are prepped. Many ingredients (e.g., garlic and shallots) will be available pre-cut for large-scale production. Other ingredients (e.g., shiitake mushrooms) will have to be cut at time of production.
3. Crickets are boiled and drained to ensure food safety.
4. All ingredients are mixed, fried and cooked for a total of approx. 20-25 minutes.
5. Final processing is performed, including homogenization in thermomixer.
6. Immediately after homogenization, the first step of the cooling process is initiated. It is essential that the product is cooled from 65° C to -10° C in a maximum of 3 hours. Time and temperature is noted when cooling starts.
7. When the paste reaches 2° C, it is removed from cooling and vacuum packed in portions corresponding to one serving for a household in Denmark or Portugal. Packs are labelled.
8. Packs are placed for second cooling step at 20° C
9. Three hours after cooling started (step 6) temperature of paste packs is noted. By this time, it must be below -10° C.

All ingredients (including crickets) are approved for human consumption. Necessary microbiological and toxicological analysis will be determined in collaboration with SUSINCHAIN WP6, focused on food safety.

### 6.2.2 Serving of the product

As previously mentioned, the paste can be used in a wide variety of dishes. Below in Table 16 is a simple recipe for a Bolognese sauce, which allows for the full flavour of the paste to stand out. The number of necessary ingredients is limited, since many flavours typically associated with a Bolognese (e.g., garlic and shallots) are already in the cricket umami paste.

**Table 16** Ingredients and quantities used to prepare Bolognese sauce

Ingredient	Quantity for Recipe (g)
Olive Oil	2.00
Carrots	50.00
Cricket Umami Paste	92.00
Tomato Pulp	200.00
Dry Pasta	90.00
Parmesan Cheese	5.00

Carrots are cut into dices of approximately 5 mm x 5 mm x 5 mm and fried briefly in olive oil. It is important that the carrots do not become soft, since their primary role is to provide texture to the dish. Cricket umami pesto is added and fried for 1 minute together with the carrots. Tomato pulp is added, and the sauce is brought to a boil and heated thoroughly before serving on pasta cooked *al dente* and decorated with parmesan cheese.

### 6.2.3 Packaging

The cricket umami pesto will be packaged in vacuum packed portions corresponding to one total serving for a household in Denmark or Portugal. The visual identity of the products will be coordinated with other SUSINCHAIN partners active in WP5. Packages will be marked with all required information for food products, including expiration date, batch number, ingredient list, nutritional content, and information on allergens.

The product is frozen as the final step of production and must be kept frozen until it is used for cooking during the intervention study. All transport will take place in accordance with legal requirements for frozen food products.

## 6.3 Batch production for T5.4 consumer trials

### 6.3.1 Production location

Production will take place at:

'Gastronomisk Innovation', Frederiksborggade 1B, 1360 Copenhagen, Denmark

The facility is certified for the production of food products intended for retail. Thus, in terms of production, the participants in the intervention study could have hypothetically bought an identical product in their local supermarket.

### 6.3.2 Product production

Production of the portions for the study (140 for Portugal and 140 for Copenhagen) will require two days of work in the above-mentioned facility. Six people will be involved in production. The production process is as follows (and also described above):

1. Receiving products. Product integrity is inspected manually and compared to order note. Ingredients are stored under designated conditions until production. Crickets are stored at -20° Celsius.
2. All ingredients are prepped. Many ingredients (e.g., garlic and shallots) will be available pre-cut for large-scale production. Other ingredients (e.g., shiitake mushrooms) will have to be cut at time of production.
3. Crickets are boiled and drained to ensure food safety.
4. All ingredients are mixed, fried and cooked for a total of approx. 20-25 minutes.
5. Final processing is performed, including homogenization in thermomixer.
6. Immediately after homogenization, the first step of the cooling process is initiated. It is essential that the product is cooled from 65° C to -10° C in a maximum of 3 hours. Time and temperature is noted when cooling starts.
7. When the paste reaches 2° C, it is removed from cooling and vacuum packed in portions corresponding to one serving for a household in Denmark or Portugal. Packs are labelled.
8. Packs are placed for second cooling step at 20° C
9. Three hours after cooling started (step 6) temperature of paste packs is noted. By this time, it must be below -10° C.

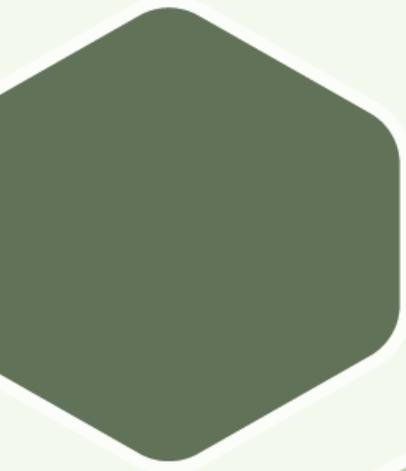
The production will follow Good Manufacturing Practice (GMP) and a HACCP plan.

### 6.3.3 Packaging, storage and shipment

The cricket umami paste will be packaged in vacuum packed portions corresponding to one total serving for a household in Denmark or Portugal. The visual identity of the products will be coordinated with other SUSINCHAIN

partners active in WP5. Packages will be marked with all required information for food products, including expiration date, batch number, ingredient list, nutritional content and information on allergens.

The product is frozen as the final step of production and must be kept frozen until the used for cooking during the intervention study. All transport will take place in accordance with legal requirements for frozen food products.



# CHAPTER 7

**`Gogga Spice` by DTU**



## Chapter 7 – ‘Gogga Spice’ Cricket spicy mix (DTU)

### 7.1 Product specification

#### 7.1.1 Composition

Gogga spice, a versatile spice mix with cricket flour as the base, could be used for preparing a dhal or other vegetable stew that contain legumes, dip for flatbread, or just as mix of spices that elevates normal dish with an exotic touch.

#### 7.1.2 Insect component of the product

The cricket flour was purchased from Entogourmet, which is a cricket farming company based in Spain. They are declared to comply with the European standards for food health and safety and have a standardised growing process. Crickets from Entogourmet are fed with EU-certified ecologically sourced feed, fresh fruit and vegetables. Crickets are pasteurized and roasted, then gently milled into a fine powder.

#### 7.1.3 Other ingredients

Ingredients for dhal and rice can be found below in section 7.2.2

#### 7.1.4 Product composition

The ingredients used and nutritional composition for the cricket mix product are shown in Table 17 and

Table 18.

**Table 17** Ingredients used to prepare cricket spice mix before processing.

<b>Ingredient*</b>
Cricket (dry, ground)
Spices
Tomato Powder
Brown Sugar

\* Quantities non-disclosed for publication

**Table 18** Nutritional composition and energy of 100 g cricket spice mix

<b>Nutrition Fact</b>	<b>Quantity (per 100g)</b>
Energy (kcal)	399.48
Energy (kJ)	1674.10
Fat (g)	10.23
Saturated Fat (g)	0.25
Carbohydrates (g)	43.13
Sugar (g)	18.85
Total Protein (g)	37.71
Insect Protein (g)	31.26
Sodium (mg)	78.78
Dietary Fibre (g)	9.36

### 7.1.5 Sensory testing

A sensory assessment is ongoing by ST, Portugal. Pre-testing in university students or school children in Copenhagen, Denmark, is planned but on hold due to COVID-19 closure.

## 7.2 Production

### 7.2.1 Processing of the product (ingredients to product)

With the exception of the cricket flour from Entogourmet, all other ingredients were ordered from Hørkram and delivered to DTU Skylab FoodLab. The further processing, including mixing powders, portioning and packaging was done in a certified kitchen facility of the Technical University of Denmark.

### 7.2.2. Serving of the product

The spice mix can be used to make dhal, which is then served with rice and can be served with optional toppings. Except for the Gogga Spice, all the aforementioned ingredients will not be included in the package and should be purchased and prepared by the consumers.

Directions to prepare the basmati rice are as followed:

1. Rinse the 60 g rice till water becomes clear.
2. Add rice and 90 g water to a pot.
3. Bring water to a boil and stir briefly to break up clumps and to evenly distribute the rice in the pot.
4. Lower the heat to simmer and cover the pot. Make sure to keep the heat low to avoid scorch at the bottom.

5. Cook the rice for 10 minutes with the lid on. Avoid lifting the lid to keep steam in the pot and to ensure even cooking result.
6. Move the pot off the heat and let the rice rest for 10 minutes with the lid on. Avoid lifting the lid to keep steam in the pot to finish the cooking process.
7. (Optional) Add 1 g cumin seeds and use a fork to gently fluff the rice before serving. Make sure to fluff very gently to break clumps without mashing the rice.

Directions to prepare the dhal are as followed:

1. Heat up a pot
2. Add 4.5 g of vegetable oil in the pot
3. Fry 1 portion (46.2 g) of Gogga Spice in the pot at low heat for 2 minutes. *\*Make sure to keep the heat low to avoid burning of the spices.*
4. Add 200 g of water and 30 g cooked lentils, 30 g chickpeas and 30 g yellow split peas to the pot.
5. Bring the mixture to a gentle boil and lower the heat to simmer for 10 minutes and season with 2 g of salt. Stir gently in between to avoid scorch at the bottom.
6. Take 1/3 portion of the dhal, blend with a hand blender or a food processor. Mix the blended dhal with the rest to achieve a creamier consistency. If the dhal is too thick, some water could be added to adjust to thickness.
7. (Optional) Top with sour cream and fresh coriander to taste.

### 7.2.3 Packaging

The package will only include the Gogga Spice and a recipe demonstrating how the mix could be used to make a dhal dish. The Gogga Spice will be vacuum-packed in pouches and could be stored and shipped at room temperature.

## 7.3 Batch production for T5.4 consumer trials

### 7.3.1 Production location

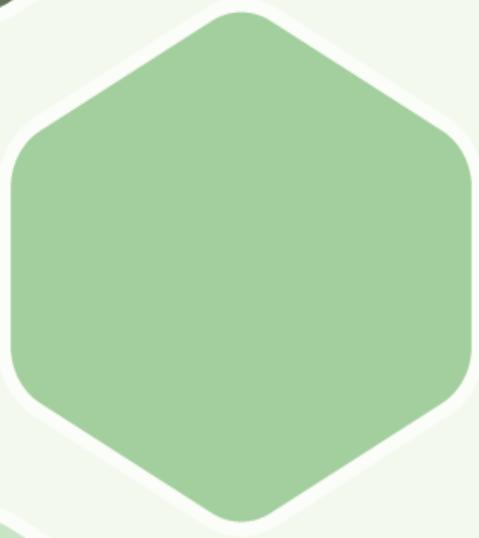
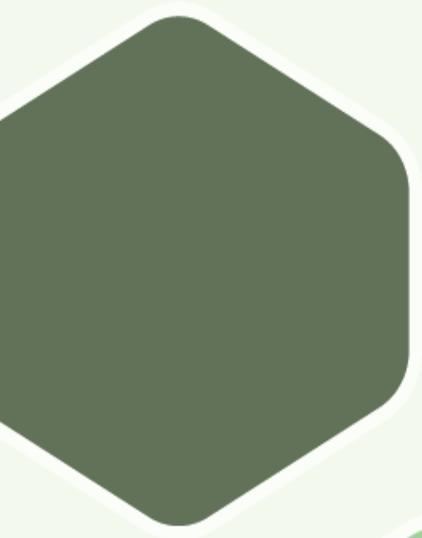
DTU Skylab FoodLab has an oral agreement with Fipros, an ingredient and food packaging company based in Denmark, which could help with processing the Gogga Spice. This is currently paused due to COVID.

### 7.3.2 Product production

To reduce any possible contamination, raw ingredients will be handled directly by Fipros. Fipros will refine each powder to achieve smaller particle sizes, weigh the amount of each ingredient needed, mix and blend the powders, and eventually portion and pack the Gogga Spice to 240 servings.

### 7.3.3 Packaging, storage and shipment

The package will only include the Gogga Spice and a recipe demonstrating how the mix could be used to make a dhal dish. The mixed powder will be vacuum-packed in pouches and can be stored and shipped at room temperature.



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