FOODLAND

Training course packages targeting food operators on the adoption and management of the technological innovations

EXTRUSION AND BAKING

Training materials on development of secondary products from farmed fish

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FOODLAND has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement (GA No 862802).

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1. FoodLAND technical innovation for local food supply chains: concepts and approaches

The FoodLAND project has the ambition to impact on a large number of supply chains and communities, hence the process of food operators' capacity development has to be tailored and as much participative as possible. Accordingly, one of the assumptions of FoodLAND is that sustainable and nutrition-responsive farming systems can be achieved basically by strengthening the capacity development, and specifically by **a)** empowering farmers and processors through the implementation of capacity building processes and concrete opportunities; **b)** creating or consolidating cooperation and shared knowledge to overcome the lack of coordination among food operators; **c)** addressing the inefficient use of resources; **d)** trying to address and build resiliency to the high vulnerability of food systems to climate change; **e)** enhancing the integration of supply chains by creating commercial and stakeholders' networks; **f)** improving the responsiveness of the production sector to the market demand.

To implement these elements of capacity development, FoodLAND proposed the adoption of specific innovations, among which the organizational ones, to create strong and responsive links between producers and encompassing all the intermediate actors along the food value chain, such as researchers, SMEs, NGOs, local and national authorities. In order to ease the creation of those links and guarantee the sustainability over time of the results, 14 Food Hubs will be created in 6 countries as part of the organizational innovations. Food Hubs are conceived as multi-actors centers of innovation where to develop or enhance the organizational and operational conditions enabling local food supply chains (D3.6).

Functional to the implementation of the Food Hubs and of the innovations, the training courses were designed – in form of capacity development activities – as a two-phase process. Firstly, a training session focused on general, preparatory

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topics was provided to farmers as described and reported in D3.5 (“Group Introductory Training”, GIT). According to the project GA, GIT broad set of goals were: to enhance the knowledge of consumers’ nutritional needs and market opportunities, and to boost the notions about climate change, sustainability, resilience, and food culture. Secondly, a specific training session were organized to provide food operators with practical information on the adoption and management of the innovations tested at lab / small scale level and to contribute to validating them at appropriate scale.

However, as the whole approach has been designed by FoodLAND to ensure the inclusion of the local actors from the first moment, both the training sessions were set up accordingly. Indeed, yet in the inception phase of the project, an assessment on participatory methods has been run and Participatory Learning and Action (PLA) approach has been eventually assessed as the best one to ensure the inclusion of multiple perspectives. The main purpose of PLA is to support people within communities to analyze their own situation, rather than have it analyzed by outsiders, and to ensure that any learning is then translated into action (Gosling and Edwards 2003). In addition, a gender-sensitive approach has been applied to the trainings that have been designed considering gender roles and power relations; they have provided equal opportunities to participate in the process by caring to times, venues and use of local languages.

The GITs have been conceived as the first step towards the innovation validation and aim at involving the producers, yet from the inception phase. They are just the first step in a sequence of 6, summed up in **Table 1**. After the GITs, where farmers and processors meet and share their vision and goals for the Food Hubs and exchange information about specific topics, the Food Hubs were created and the innovation tested (first in pre-test, then in pilot phase). The constant iteration between researchers and local actors is a key feature of the project: specifically, the practical trainings focused the single innovations (step 5) are aimed at validating the innovations at adequate scale and planned to trigger feedback loops of control and improvement involving developers and adopters.

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Table 1. Activities with farmers and food processors (SMEs) and participatory approach

Step	1	2	3	4	5	6
Task	**T3.3**	**T3.3**	**T3.4**	**T4.1¸T4.5**	**T5.1¸T5.5**	**T5.1¸T5.5**
Activity	Group introductory training	Food Hubs creation	Innovation undertaking	Innovation tests	Individual and group practical training	Innovation pilot and validation

2. FoodLAND practical training: aims and scope

According to the project bottom-up and participatory approaches, following the courses on introductory topics GIT organized in the early project phase (T3.3), and as component creating / strengthening the Food Hubs as local innovation centres, FoodLAND has organized a second set of training activities with food operators based on active learning methods and gender equality principle (Task 5.1-5.9). In this regard, specific mechanisms (being aware of the gender roles and power relations; providing equal opportunities to participate in the process by putting attention to the times, venues, use of local languages, etc.) will be lifted to ensure women's participation. These training packages are aimed at providing the local farmers and food processors with operational instructions on the adoption and management of the validated innovations.

This second set of training activities has been organised – triggering PLA approach – as individual and group practical (demonstration/capacity building) activities to be conducted in parallel to the implementation of the technological research (where relevant) and of the innovation pilots and validation. These technology-centred trainings aim at strengthening the participants' understanding of novel production and post-harvest techniques, innovative tools and systems (e.g., climate smart/precision agriculture, hydroponics, and integrated aquaculture), new technologies for primary and secondary processing, and supply chain management. Thus they aim at fostering knowledge and operational

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capacity to deploy, manage, and maintain the validated technological innovations – documented by the released guidelines D4.1 ÷ D4.11 (e.g., training pamphlets, user manuals, flow diagrams, and operational recommendations) and practice abstracts D6.5 – validated jointly at appropriate scale.

3. Second training packages on the adoption and management of the tested innovations: an overview

The second training course aimed at consolidating the food operators' knowledge and practical skills to adopt, manage and validate the project innovations and complement the related guidelines. Specifically, the realized training materials provide local farmers and food operators with a set of notions and concrete information on a series of innovative tools and systems as per the following **Table 2**. It is clear that both the contents and formats of the learning packages widely differ across technologies as well as Food Hubs (when the same type of innovation must be validated in different contexts). The diversity that emerges from the proposed solutions reflects the different needs highlighted by farmers and stakeholders as well as the conditions and opportunities characterizing the local communities. Nevertheless, in order to take into due account the existing heterogeneity inside the local communities, the developed learning materials have been let available on the project intranet so as to be used for further training initiatives across the network of Food Hubs.

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4. Second training packages on practical information on the adoption and management of the tested innovations

Extrusion and baking

Training materials on development of secondary products from farmed fish

Target group: Fish farmers, processors, extension workers and traders

Aim of Training: To impart knowledge on low cost artisanal processes for preservation and value addition of farmed fish

Learning Outcomes: By the end of the training, the participants should be able to:

identify and implement the value of maintaining the quality and safety of fish raw materials and finished products

create a demand for increased production that will lead to increased market niches for increased incomes

Topics for training

Introduction and overview to value addition
Sanitation and hygiene
Fish spoilage
Fresh fish handling
Quality and safety
Fish processing/preservation methods
Product diversity (secondary products)
By-products processing

Teaching & Learning Methods:

Practical (hands on), power point presentations, excursion, discussions/brainstorming

Training materials Description

This material/module focuses on good hygienic and sanitary practices in handling and processing of farmed fish. It also provides information on mechanisms and drivers of fish spoilage. The standard operating procedures for handling and processing of fresh fish, and preparation of mince are included. Lastly, protocols for preparation of secondary fish products namely; fish balls, nuggets, crackers and an extruded fish bone-maize snack are detailed.

Assessment Methods and duration

Learners demonstrating what they have learned
6hrs; 2 hrs of class; 4 hrs of practical

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Overview/Introduction

Fish and fishery products represent valuable sources of nutrients and contribute to diversified and healthy diets (FAO, 2013). Fish meat is a source of high biological value proteins, polyunsaturated fatty acids, vitamins and minerals, with the minerals mainly concentrated in the bones (Kabahenda et al., 2011). The recognition of fish as a healthy meat by health-conscious consumers has led to the development of convenient fish products such as fish sausages, fish balls, fish burgers, as a way, not only to promote consumption but also add value to fish products for more earning by the traders. There is increased demand for affordable fish products so as to optimize the nutritional benefits by many consumers in the country. Fish products may not be affordable by many communities especially the low-income earners yet they need the fish to access some of the best protein sources and other nutrients from fish. Fish products such as balls, samosas, sausages among others could be affordable when they are processed in affordable quantities by many consumers. In addition, there are more bi-products we can get from the fish some of which may include the fish bones. Some of these products can be fortified with other products or food types and become cheaper and accessible by many consumers. Good processing of fish products can benefit both the consumers and the fish farmers. Fish farmers will earn more money from the value-added products and on one hand consumers will get what is affordable for them. Research has to continuously develop quality good products for consumers. The focus in the current study has been put on development of these products including the fish bones. Unfortunately, the fish bones have not been considered important as part of the key fish product. Product developers only consider the fish mince which is low in calcium. Fish bones or skeleton, are by- products from production of fillets or mince and constitute approximately 10-15% of total fish biomass (Toppe et al., 2007) and are high in calcium, (Luu & Nguyen, 2009). This study sought to compare secondary products including fish balls, fish crackers, and fish nuggets from the fish mince and extruded snacks from the fish bones of tilapia and African catfish.

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Fish bones are a potential source of calcium for enrichment of other food materials. For instance, dry tilapia contains approximately 234 g/Kg of calcium respectively (Hemung & Sriuttha, 2014; Kabahenda et al., 2011). Therefore, utilization of fish bones in the production of calcium rich extruded food products is a very important subject of research (Bubel et al., 2015; Kabahenda & Husken, 2009; Muralidharan & Shakila, 2013Nemati et al., 2017; Yin, Park, & Xiong, 2017). Extrusion converts commodities, usually in a granular or powdered form, into fully cooked, shelf-stable food products with enhanced textural attributes and flavor primarily in the cereal, dairy, bakery, confectionery and pet food industries (Patil et al., 2007, and Berrios et al., 2008). Extrusion offers numerous advantages including versatility, high productivity, low operating costs, energy efficiency, high quality of resulting products and an improvement in digestibility and biological value of proteins (Gutiérrez-Dorado et al., 2008).

Sanitation and hygiene

Sanitation **refers to** environmental and surrounding cleanliness

Hygiene **refers to** Personal/ self cleanliness.e.g communicable diseases, health aspects, sanitation,

Why should we keep the environment clean?

Why should a person be clean?

Why should a fish processing plant and operatives/workers be clean?

Why Hygiene and sanitation

Ensure safety of fish and its products

Assure the market/consumers of standard operation practices in handling fish

Avoid contamination

Reduce infections and food poisoning

Ensure and maintain natural test of fish

Ensure quality and attach markets/ consumers ultimately high priced fish products

Increase shelf life of fish and its products

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Hygiene and sanitation practices

At farm level

Maintain proper disposal of solid waste

Use clean toilets/latrines for disposal of excreta

Use proper wastewater drainage systems

Control animal movement at the fish processing site

At personal level

Always wash hands

You must not work when suffering from contagious infections to avoid transmission and contaminating the fish.

Wear clean protective clothing e.g. aprons, overcoats, headgears

Keep spare clothes and other personal items away from fish.

Ensure proper body hygiene e.g. bathing, trimming hair, nails

Avoid wearing jewelry on your hands when handling fish

Cover cuts or wounds with wound strip or a bandage

Wear disposable coloured gloves over the top of the wound strip if you have wounds on your hands.

Fish spoilage

What is fish spoilage?

Deterioration that renders fish unsuitable for consumption

Why does fish spoil?

- High moisture content (65 – 80%)
- Very soft muscles

Highly susceptible to microbial spoilage

Rigor mortis phenomenon as a precursor for spoilage:

Pre-rigor and post-rigor

Mechanisms of spoilage:

Autolytic/self digestion (enzymic)

Microbial e.g. spoilers

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Chemical (oxidative rancidity)

Main drivers of spoilage:

Time after death/ post-mortem

Temperature

Initial microbial load

Chemical composition

Handling practices

Other factors that drive spoilage

Fish condition (spawning, wellness, stress)

Sex

Type of species

Handling of farmed fresh fish

Because fish is perishable, it should be handled with care – No bruises.

Ensure humane killing of fish e.g use of ice, CO_2, or electricity.

Dip fish in a settlement water tank to remove muddy flavors before humane killing.

Do not degut or descale fish in absence of clean water and flake ice.

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Secondary processing

Raw Materials Handling

Upon reception of live fish, an incision is made at the back of the head to allow for bleeding. Bleeding is done in a white container with water.

Keep emptying/refilling the container until the water remains clear, indicating that bleeding has stopped.

After bleeding, the fish is covered with ice to facilitate humane death overnight.

The fish is washed, filleted and washed again before being put on a shallow tray.

The guts are removed and collected in a separate bucket.

The carcass is washed and deboned using a deboner to separate the bones from the mince.

In cases where the mince from the carcass is insufficient, the fillet can also be minced using an electric mincer.

The mince is used in the preparation of fish balls, fish nuggets and fish crackers.

On the other hand, the bones are dried in an electric dryer at 60 °C until brittle and then milled (refer to primary processing manual)

The powder from the bones is used in the preparation of extruded snacks

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Figure 1. Preparation of fish mince

Processing Protocols

Fish balls

The fish balls were prepared according to Duman and Peksezer (2016) (**Fig. 2**).

Fish balls were composed of 64% fish mince and 36% other ingredients, including: 18% wheat flour, 11.4% onions, 1.8% bread crumbs, 3.8% fat, 0.7% salt and 0.26% black pepper.

All the ingredients were mixed together to form a uniform dough.

This basic mixture was processed to form small (25 g) balls which were deep fried using vegetable oil (Roki).

Deep frying was done at 200 °C for approximately 15 minutes (till golden brown).

Excess oil was drained from the fish balls on a paper towel and then allowed to cool .

The fish balls were wrapped in Aluminium foil and kept in a refrigerator (4 °C) for subsequent analysis.

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Figure 2. Preparation of fish balls

Fish nuggets

The fish nuggets were prepared according to methods by Moosavi Nasab et al. (2018) with slight modification (**Fig. 3**).

The nuggets contained fish mince (80.24%), water (9.95%), lemon (0.30%), onion (6.01%), spices (0.36%), wheat flour (1.90%), and sugar (0.2%).

All ingredients were mixed to form a dough.

The nuggets were made into star shapes using a cutter, coated with bread crumbs and deep fried with vegetable oil (Roki) at 200 °C for 15 minutes.

Excess oil was drained using paper towel and the nuggets allowed to cool.

They were then wrapped in Aluminium foil and kept in the refrigerator (4 °C) for subsequent analysis.

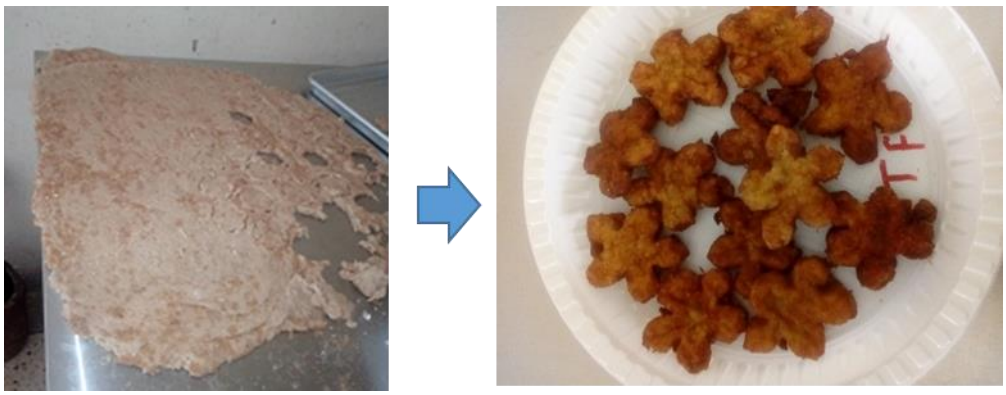

Figure 3. Preparation of fish nuggets

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Fish crackers

The crackers were made by following the method BY Zzaman et al. (2017) with slight modification.

Crackers were made by mixing 200 g fish mince, 180 g tapioca starch, 12 g sugar, 13.5 g salt, 30.5 g ice, 3 g MSG, and 2.1 g sodium bicarbonate.

The dough was made into cylindrical shapes with 4.3 cm diameter and steamed at 90°C for 30 minutes (until firm) followed by chilling in a refrigerator (4 °C) for approximately 1 hour.

They were cut into 2 mm thick pieces which were oven dried at 50°C for 12 hours.

They were deep fried in hot vegetable oil (Roki) for 30 seconds.

Extruded fish bone-maize snack

Fish powder was prepared from the fish bones (**Fig. 4**).

Maize grits were ground to pass through 200 µm sieve using laboratory mill.

Several preliminary trials were made to select the mixing ratio of fish flour incorporation in maize flour.

The fish bone flour was mixed with the maize flour in the ratio of 1:2 in the ribbon blender for 15 min to ensure uniform mixing.

Salt and dried spices of choice (in powder form) were added at 2% into the mixture and again blended for 10 min (Savile et al., 2011).

The mixture was introduced in the extruder hopper and extruded at 150 °C, screw speed - 1450 rpm and cutting speed 350 rpm.

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The extruded products (moisture content 17%) were cooled for 5 minutes and packaged immediately in a lined polypropylene bag to prevent moisture absorption from the atmosphere.

Figure 4. Preparation of extruded fish bone-maize snack

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