

AdriAquaNet

Enhancing Innovation
and Sustainability in
Adriatic Aquaculture



NUTRITIONAL VALUE AND HEALTH BENEFITS OF FISH CONSUMPTION



Name of the project: *AdriAquaNet – Enhancing Innovation and Sustainability in Adriatic Aquaculture*

Priority: Blue Innovation

Duration: 1.1.2019 – 30.6.2022

Coordinator: University of Udine, Italy
Department of Agricultural, Food, Environmental and Animal Sciences

Contact: Prof. Marco Galeotti
marco.galeotti@uniud.it



Publisher: University of Rijeka, Faculty of Tourism and Hospitality Management

Authors: Elena Dujmić, Greta Krešić, Dina Lončarić, Anamarija Buneta

Graphic design: Foxstudio Ltd

Photography: Orada Adriatic Ltd, Friškina Ltd, David Skoko, Shutterstock.com

Print: Tiskara Sušak

Opatija, 2021

ISBN 978-953-7842-49-9 (print) / 978-953-7842-50-5 (online)

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AdriAquaNet – Enhancing Innovation and Sustainability in Adriatic Aquaculture

Today's need for fish is constantly growing due to both population growth and recommendations by experts for its consumption. However, since natural resources are limited, it is impossible to ensure this increasing need without aquaculture.

The current scientific consensus is that farmed and wild fish cannot be differentiated in terms of nutritional value and safety. However, **farmed fish poses some advantages in comparison to the wild one:**

- Constant chemical composition, influenced by feed (particularly fatty acids profile)
- Cheaper option
- Available all year round

AdriAquaNet project is the first-ever initiative for sustainable improvement of the quality of farmed fish and its marketing which resulted from the cooperation between Italy and Croatia. Within the project, along with the lead partner, four industries, one consortium and six research institutes from both sides of the Adriatic Sea teamed up to develop and apply innovative technologies for fish farming and marketing high-quality fish.

The novel feed formulations and feeding protocols have a low impact on the environment and at the same time they improve fish quality. The applied smart technologies reduce greenhouse emissions by exploiting aquaculture waste while obtaining usable biogas as renewable energy. Innovative solutions used in combating fish diseases (such as usage of probiotics, natural compounds and vaccines) enhance fish welfare and ensure safe products for consumers. High nutritional quality of fish is preserved over an extended time by innovative packaging methods.



NUTRITIONAL VALUE

Fish has always been a fundamental part of human nutrition, this applies in particular to the Mediterranean diet which is nowadays a golden standard for healthy eating. Because of its numerous health benefits, various health organizations and national authorities recommend the consumption of at least **2 servings of fish per week**.

One serving accounts for 120 – 170 g of clean fish meat.

Most of the nutrients present in the fish meat constitute an optimal amount for the human organism. Although there is a whole range of different species, most of the fish contain the same key nutrients, however, in different amounts.

Fish is a high protein food, low in calories and fat, and a valuable source of vitamins and minerals.

ENERGY VALUE

Fish is generally lower in calories than other protein-rich food. Most lean fish species contain less than 100 kcal *per* 100 g, whereas fatter species contain approximately 250 kcal or less *per* 100 g. For that reason, fish makes an excellent choice for people who want to lose weight or maintain an ideal weight.



PROTEINS

Proteins are major functional and structural components of all body cells, meaning they are building muscles, skin, blood, and all the internal organs. They are important for growth and regeneration, as well as for the production of enzymes and hormones necessary for proper body functioning.

One serving of fish provides about one third to one half of the daily protein requirement.

Fish is an excellent source of high-value proteins, containing all essential amino acids. It is a good alternative to red meat which should be limited in daily diet. In comparison to meat, fish proteins are highly digestible due to its structure of shorter muscle fibres and low connective tissue content, so there is a little possibility that the feeling of heaviness in the stomach will appear after its consumption.





FATS

Fats are the most concentrated source of energy in the human diet. They are structural components of cells, they facilitate absorption of fat-soluble vitamins (A, D, E, K), and have several important biological functions including growth and development.

The explanation for the low caloric value of fish lies in the lower fat content compared to the meat of other origins. Even more, it contains less saturated fatty acids whose excessive consumption nowadays is associated with increased incidences of various diseases. Thus, nutritionists recommend a reduced intake of saturated and an increased intake of unsaturated fatty acids.

Depending on the amount and distribution of fat, fish is classified as lean or fatty. Since the colour of fish meat is related to fat content, the leanest species have a white and lighter colour, whereas fatty fish have a much darker colour. A large proportion of the fat in fish is **polyunsaturated, including omega-3 fatty acids which are highly recommended in a health-protective diet.**

OMEGA-3 FATTY ACIDS

Omega-3 fatty acids are essential, which means that the body cannot synthesize them and therefore they must be obtained from the food. They have an important role and positive effects on bodily processes, such as **inflammation**, **heart health**, and **brain function**.

The most important omega-3 fatty acids in human nutrition are:

- **alpha-linolenic acid (ALA)**
- **eicosapentaenoic acid (EPA)**
- **docosahexaenoic acid (DHA)**

While ALA is mostly found in plant foods (nuts, seeds, oils), EPA and DHA are mostly found in seafood.

ALA can be converted to EPA and DHA but the process is inefficient, especially because these conversions can be competitively slowed by some omega-6 fatty acids. Since omega-6 fatty acids have a pro-inflammatory effect, recommendations are focused on increased omega-3 fatty acids intake due to their positive anti-inflammatory effect. Given the fact that the modern Western diet contains a higher proportion of omega-6 fatty acids over omega-3 fatty acids (15:1), far from the desired ratio (4-5:1), the importance of consuming fish is emphasized.

Even though omega-3 fatty acids are present in larger quantities in fatty fish, lean fish is also a valuable source as the recommended daily intake can be achieved by eating lean fish as well.



VITAMINS AND MINERALS

Fish is a natural source of vitamins and minerals although their concentration is variable according to species, age, season, or feeding regime of the fish. Minerals in fish are highly bioavailable meaning that our body can easily absorb them.

VITAMINS **B**

Help to convert food into energy in the cells of the body.
Needed for the healthy development of the nervous system.

VITAMIN **A**

Important for normal vision.
Needed for a healthy immune system.

VITAMIN **D**

Helps the absorption and utilization of calcium and phosphorus.
Needed for a healthy immune system.

VITAMIN **E**

Antioxidant activity, protecting cells from damaging effects.

Mg Magnesium

Needed for normal nerve and muscle function.
Regulates blood sugar and blood pressure.

P Phosphorus

Needed for formation of bones and teeth.

Se Selenium

Antioxidant activity, protecting cells from damaging effects.

Zn Zinc

Needed for regular growth and development.
Needed for a healthy immune system.

I Iodine

Helps to maintain thyroid gland function.

Fe Iron

Participates in red blood cells production.

K Potassium

Helps to maintain normal levels of fluids inside cells.

Ca Calcium

Needed for formation of bones and teeth.

FISH IN THE DIET OF CHILDREN

Fish, in general, is great for health in all life stages but can be particularly beneficial for children as they are rapidly growing and developing. Fish contains key nutrients that promote healthy growth and development throughout childhood and can help minimize chronic disease risk later in life.

Introducing fish into a child's diet from an early age will not only provide them with needed nutrients but it will encourage them to introduce healthy eating habits that can persist into adulthood. However, parents often encounter difficulties when serving fish to children because it has a specific taste and smell.

Some useful tips for parents which can increase fish consumption:

- **Start with lean fish** that has a mild taste, and then slowly introduce other species.
- Be **creative when serving the dish** as it can affect the appeal of fish.
- **Mix fish** with children's favourite foods such as pasta, tortilla, or even insert it as a snack or as a part of a sandwich.
- **Involve children in the preparation of fish** since preparing food together can help to increase their appetite and, at the same time, it will be a fun activity to do together.
- Be consistent and **serve fish twice a week** so that it becomes something familiar to the child.

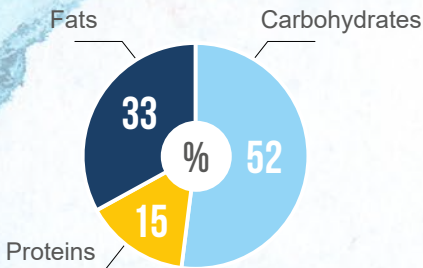
Recommended fish intake for children does not differ from adults — children should eat at least two servings of fish per week, too. Those over 12 years of age can eat the same amount as adults, while serving sizes for younger ones should be smaller and adjusted for their age and energy needs.

Age	One serving size
18 months to 3 years old	¼ – ¾ small fillet or 1 – 3 tablespoons
4 to 6 years old	½ – 1 small fillet or 2 – 4 tablespoons
7 to 11 years old	1 – 1 ½ small fillets or 3 – 5 tablespoons
12 years old to adult	140 g fresh fish or 1 small can

DAILY MENU for children 4 – 6 years old



Macronutrient ratio



BREAKFAST	379 kcal
Milk	Milk, whole 250 ml (1 cup)
Sea bass pâté	Sea bass, fillet 25 g Egg 5 g (1/8 piece) Lemon juice 5 g (1 teaspoon) Olive oil 2 g (1/2 teaspoon)
Bread	Bread, wholegrain 70 g (2 slices)
SNACK	100 kcal
Fruit	Tangerines 240 g (4 medium)
LUNCH	547 kcal
Barley lentil stew	Barley 30 g Lentil 20 g Carrot 25 g Onion 10 g Oil 4 g (1 teaspoon)
Cabbage salad	Cabbage 70 g Olive oil 4 g (1 teaspoon)
Bread	Bread, wholegrain 35 g (1 slice)
Marble cake	Marble cake, homemade 60 g (1 piece)
SNACK	140 kcal
Yoghurt with chia seeds	Yoghurt 150 ml Chia seeds 4 g (1 teaspoon) Dried cranberries 20 g
DINNER	338 kcal
Spaghetti with sea bass in tomato sauce	Spaghetti 50 g Sea bass, fillet 40 g Tomatoes, canned 50 g Tomatoes, cherry 35 g Onion 15 g Olive oil 4 g (1 teaspoon)
Green salad	Green salad 60 g Olive oil 4 g (1 teaspoon)
TOTAL ENERGY VALUE*	1504 kcal 6320 kJ

*determined by Nutritics v5.53 software

Omega-3 fatty acids 1.4 g
Calcium 816 mg
Iron 9.8 mg

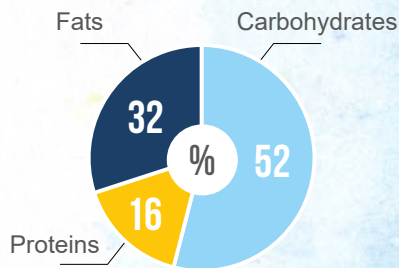
DAILY MENU for children 7 – 9 years old

BREAKFAST	398 kcal
Semolina porridge with cocoa	Milk, semi-skimmed 300 ml Semolina 30 g Honey 14 g (2 teaspoons) Cocoa 15 g (1 tablespoon)
Fruit	Apple 120 g (1 small)
SNACK	177 kcal
Cookies, lemonade	Tea cookies 30 g Lemonade 200 ml
LUNCH	643 kcal
“Breaded” sea bream in the oven	Sea bream, fillet 110 g Sesame seeds and oat flakes 20 g Olive oil 4 g (1 teaspoon) Pepper, garlic powder
Roasted sweet potatoes	Sweet potato 250 g Parmesan 5 g (1 teaspoon) Olive oil 4 g (1 teaspoon)
Green salad	Green salad 80 g Olive oil 4 g (1 teaspoon)
SNACK	221 kcal
Blueberry smoothie	Yoghurt 180 ml Blueberries 50 g Banana 80 g (1 small) Flaxseed 4 g (1 teaspoon)
DINNER	361 kcal
Pea stew with dumplings	Peas 125 g Carrot 60 g Onion 35 g Flour, wheat 25 g Egg 25 g (½ piece) Olive oil 4 g (1 teaspoon) Ground paprika, parsley
Bread	Bread, wholegrain 35 g (1 slice)
TOTAL ENERGY VALUE*	1800 kcal 7570 kJ

*determined by Nutritics v5.53 software



Macronutrient ratio



Omega-3 fatty acids	2 g
Calcium	1066 mg
Iron	13.1 mg

FISH IN THE ATHLETES' DIET

Fish is a favourite food among athletes because of its high protein content. Although most people easily get enough protein in the diet, athletes have higher needs for this nutrient because of its breakdown during exercise that needs to be replenished. However, except for protein, athletes might find additional benefits of including fish into their diet.

Five reasons why athletes should regularly eat fish:

- **Lose body fat** – fish is great for losing adipose tissue, either to obtain better performance or better body composition.
- **Muscle recovery** – omega-3 fatty acids may help reduce inflammation post-workout, making an athlete less prone to injury and aiding quicker recovery time.
- **Boost intake of B-complex vitamins** – due to higher energy expenditure, athletes need almost twice as much B-vitamins.
- **Antioxidative effect** – expected consequence of long-term physical activity is oxidative stress of muscle and other cells; antioxidants help to counteract the potential damage.
- **Improve focus and mind acuity** – omega-3 fatty acids, particularly DHA, improves cognition.

Busy training schedules, competitions and travelling can make it difficult to eat a well-balanced diet. Luckily, fish is easy to prepare and cook – ideal when there is a shortage of time. Some examples of tasty and easily prepared fish meals:

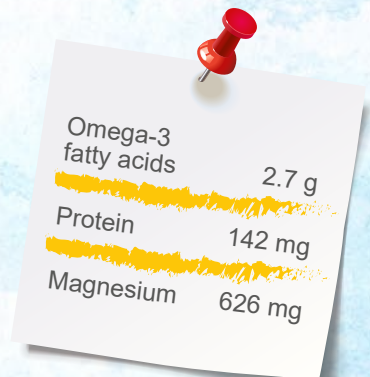
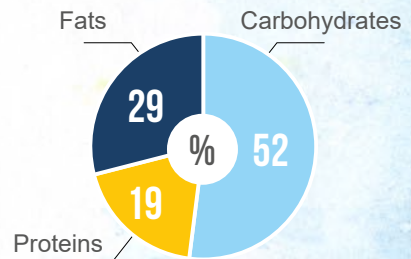
- grilled fish with potatoes and vegetables
- baked fish en papillote with vegetables
- fish salad
- sandwich with fish pâté
- tortilla wrapped fish
- fish stew cooked in white wine and tomato sauce

DAILY MENU for an athlete with energy requirements of 3000 kcal

BREAKFAST	674 kcal
Oatmeal	Milk, semi-skimmed 300 ml Oat flakes 80 g Apple 160 g (1 medium) Walnuts 15 g Honey 14 g (2 teaspoons)
SNACK	296 kcal
Tropical smoothie	Banana 120 g (1 large) Mango 120 g Fresh-squeezed orange juice 300 ml
LUNCH	1009 kcal
Pan-roasted chicken	Chicken breasts 170 g Olive oil 4 g (1 teaspoon)
Boiled rice	Rice 130 g Butter 7 g
Boiled vegetables	Carrots 120 g Broccoli 100 g Olive oil 8 g (2 teaspoons)
Bread	Bread, wholegrain 70 g (2 slices)
SNACK	320 kcal
Yoghurt, wholegrain crackers	Yoghurt 250 ml (1 cup) Wholegrain crackers 40 g
DINNER	708 kcal
Sea bream en papillote with vegetables	Sea bream, whole gutted 320 g Zucchini 200 g Tomatoes, cherry 120 g Potatoes 250 g Lemon juice 30 g (2 tablespoons) Olive oil 19 g (1.5 tablespoons) Rosemary, thyme, garlic, pepper
TOTAL ENERGY VALUE*	3007 kcal 12665 kJ



Macronutrient ratio

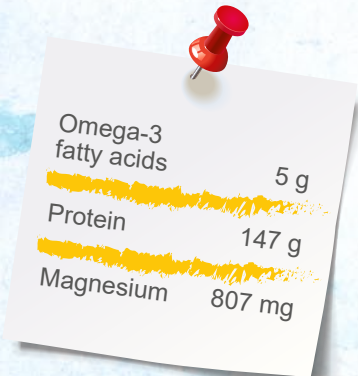
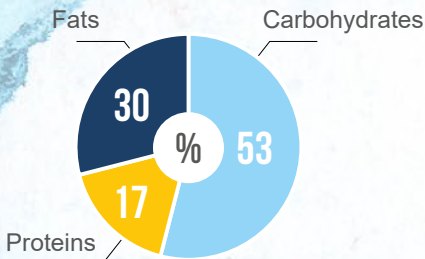


*determined by *Nutritics v5.53* software

DAILY MENU for an athlete with energy requirements of 3500 kcal



Macronutrient ratio



BREAKFAST	805 kcal
Yoghurt with flaxseed and raisins	Yoghurt 250 ml (1 cup) Flaxseed 14 g (1 tablespoon) Raisins 40 g
Bread with jam	Bread, wholegrain 140 g (4 slices) Fruit jam 60 g
SNACK	456 kcal
Fruit salad with ice cream	Banana 120 g (1 large) Kiwi 220 g (3 pieces) Vanilla ice cream 60 g Almonds 15 g Honey 21 g (1 tablespoon)
LUNCH	1062 kcal
Sea bass with broad beans and potatoes	Sea bass, fillet 200 g Olive oil 13 g (1 tablespoon) Lemon, parsley, pepper Broad beans 100 g Potatoes 350 g Fennel 90 g Olive oil 13 g (1 tablespoon)
Tomato salad	Tomatoes 150 g Olive oil 4 g (1 teaspoon)
Fruit juice	Apple juice 300 ml
SNACK	441 kcal
Raspberry rice pudding	Milk, semi-skimmed 250 ml (1 cup) Rice 70 g Raspberries 60 g Honey 21 g (1 tablespoon)
DINNER	744 kcal
Creamed spinach	Spinach 250 g Milk, semi-skimmed 125 ml Flour, wheat 10 g Butter 7 g
Fried eggs	Egg 150 g (3 pieces) Oil 4 g (1 teaspoon)
Bread	Bread, wholegrain 140 g (4 slices)
TOTAL ENERGY VALUE*	3508 kcal 14768 kJ

*determined by *Nutritics* v5.53 software

FISH IN THE DIET OF THE ELDERLY

Fish meat (without bones) is great for the elderly because of its structure that facilitates easy consumption, avoiding difficulties that can often be encountered with chewing and swallowing. Diet planning in older age becomes much more demanding since the body needs less amount of energy, but the needs for nutrients remain the same or even increase. Eating fish is a good way for older adults to provide a variety of nutrients and thus achieve beneficial health effects.

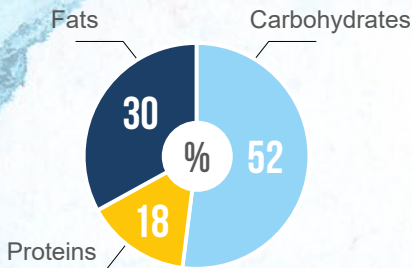
Health benefits

- Omega-3 fatty acids in fish help **reduce inflammation** that can damage blood vessels and lead to **coronary heart disease (CHD)**, the leading cause of mortality worldwide. Age is one of the significant risk factors for CHD, starting at the age of 55.
- Eating fish can **delay muscle loss and prevent physical decay**. There is strong evidence that higher protein intake (extending to 1.5 g/kg body weight) may have a beneficial effect on the protection of muscle mass and strength in the elderly.
- Fish has essential nutrients to **maintain proper bone density**. By the age of 40, men and women (especially after menopause) slowly begin to lose bone mass or bone density. Severe bone loss that in the older age represents the risk of bone fractures and osteoporosis can be avoided by regular fish consumption.
- Nutrients found in fish, especially omega-3 fatty acids, help **improve cognitive health**. People who eat fish more often have a lower risk of developing Alzheimer's and other types of dementia.
- **Fish promotes longevity**. Excessive production of free radicals and reduced antioxidant defence, that happens with age, significantly contribute to ageing. Eating fish is a good way to prevent cell oxidation because of its antioxidant effects.

DAILY MENU for women older than 75 years



Macronutrient ratio



Omega-3 fatty acids	2.7 g
Calcium	1038 mg
Vitamin B12	6.6 µg
Fibre	37.5 g

BREAKFAST	450 kcal
White coffee	Milk, semi-skimmed 250 ml (1 cup) Coffee substitute 3 g (1 teaspoon) Sugar 2.5 g (½ teaspoon)
Cottage cheese and sour cream	Cottage cheese 70 g Sour cream 20 g Flaxseed 8 g (2 teaspoons)
Bread	Bread, wholegrain 70 g (2 slices)
SNACK	101 kcal
Apple compote	Apple, peeled 150 g (1 medium) Sugar 10 g (2 teaspoons) Cinnamon
LUNCH	640 kcal
Poached sea bass with vegetables	Sea bass, fillet 120 g Carrot 120 g Leek 50 g Zucchini 80 g Tomatoes 80 g Onion 30 g Olive oil 13 g (1 tablespoon) Rosemary, thyme, garlic
Polenta	Cornmeal 70 g
SNACK	143 kcal
Yoghurt with strawberries	Yoghurt 180 ml Strawberries 100 g
DINNER	467 kcal
Buckwheat mushroom stew	Buckwheat groats 40 g Mushrooms 50 g Lentil 30 g Onion 20 g Celery, root 20 g Carrot 40 g Tomato sauce 30 g (1 tablespoon) Oil 4 g (1 teaspoon) Ground paprika, parsley
Bread	Bread, wholegrain 70 g (2 slices)
TOTAL ENERGY VALUE*	1801 kcal 7576 kJ

*determined by *Nutritics* v5.53 software

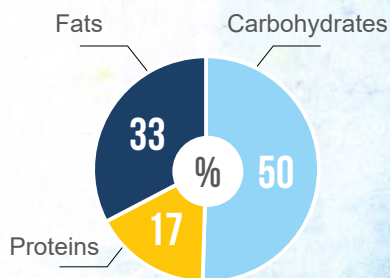
DAILY MENU for men older than 75 years

BREAKFAST	475 kcal
Oatmeal	Milk, semi-skimmed 250 ml (1 cup) Oat flakes 50 g Banana 100 g (1 medium) Chia seed 10 g Honey 14 g (2 teaspoons)
SNACK	228 kcal
Dried fruit, cashews	Mixed dried fruit 40 g Cashews 20 g
LUNCH	751 kcal
Homemade fish soup	1 cup
Boiled sea bream	Sea bream, whole gutted 300 g Olive oil 8 g (2 teaspoons) Parsley, garlic
Swiss chard with potatoes	Swiss chard 250 g Potatoes 125 g Olive oil 4 g (1 teaspoon)
Bread	Bread, wholegrain 35 g (1 slice)
SNACK	275 kcal
Chocolate pudding	Milk, semi-skimmed 250 ml (1 cup) Pudding powder, chocolate flavour 20 g Sugar 20 g
DINNER	472 kcal
Cold pasta salad	Pasta, wholegrain 90 g Feta cheese 30 g Tomatoes, cherry 140 g Cucumber 70 g Bell pepper 60 g Olives 10 g Olive oil 4 g (1 teaspoon) Basil
TOTAL ENERGY VALUE*	2201 kcal 9256 kJ

*determined by *Nutritics* v5.53 software



Macronutrient ratio



Omega-3 fatty acids	3.2 g
Calcium	1228 mg
Vitamin B12	9.3 µg
Fibre	37.4 g

DID YOU KNOW?

Half of all fish consumed today originates from aquaculture.

Fish is a valuable source of vitamins which are commonly underrepresented in human nutrition: vitamins A and D.

Fish is the best source of iodine in the human diet.

Small fatty fish that is eaten with their bones is a significant source of calcium.

People living on the Mediterranean coast have a low incidence of degenerative diseases, which is attributed to a specific diet that includes fish along with olive oil, fruits and vegetables.

To preserve the nutritional value of fish, the order of selection of fish preparation methods should be:

1. Baking without added fat
2. Cooking
3. Frying or roasting fish with the addition of fat.



THE PARTNERS

RESEARCH INSTITUTES

- LP UNIVERSITY OF UDINE
Dept. of Agricultural, Food, Environmental and Animal Sciences
- PP1 CROATIAN VETERINARY INSTITUTE
- PP2 UNIVERSITY OF TRIESTE – Dept. of Life Sciences
- PP3 INSTITUTE OF OCEANOGRAPHY AND FISHERIES
- PP4 ISTITUTO ZOOPROFILATICO SPERIMENTALE DELLE VENEZIE
- PP5 UNIVERSITY OF RIJEKA
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- PP6 NATIONAL RESEARCH COUNCIL OF ITALY
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CONTACT

University of Udine

Department of Agricultural, Food, Environmental and Animal Sciences

Prof. Marco Galeotti

marco.galeotti@uniud.it

European Regional Development Fund