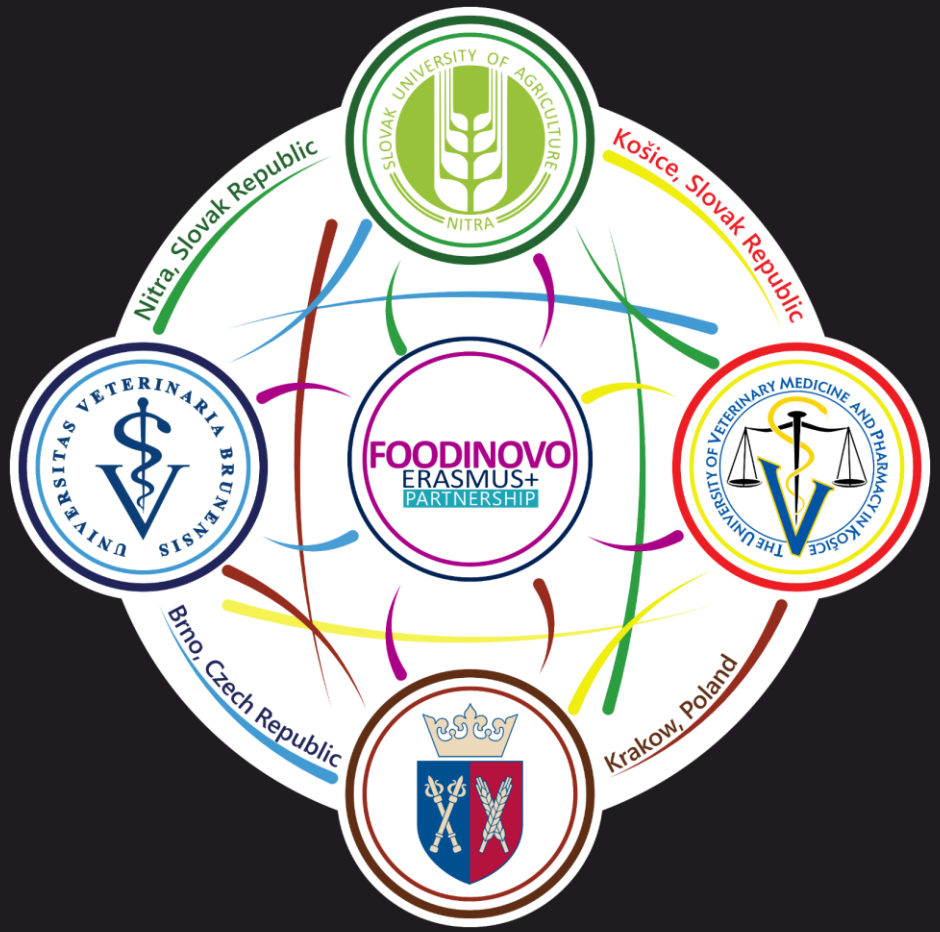
Impact of Technological Processes on The Health Safety and Quality of Fish and Fishery Products



Co-funded by the Erasmus+ Programme of the European Union

Production of fish

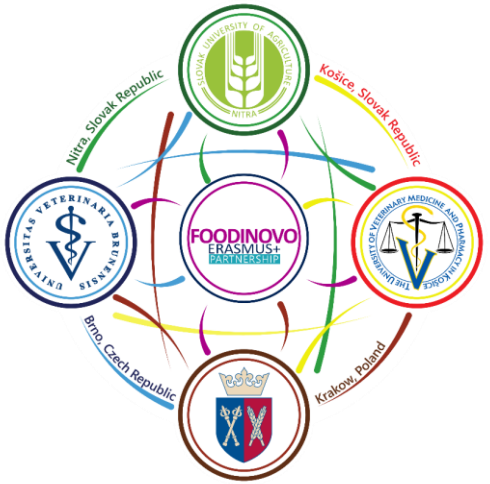
World fish production (million tonnes) and exploitation in 1986-2018

	1986 - 1995	1996 - 2005	2006 - 2015	2016	2017	2018
Production						
Freshwater capture	6.4	8.3	10.6	11.4	11.9	12.0
Marine capture	80.5	83	79.3	78.3	81.2	84.4
Capture total	**86.9**	**91.4**	**89.8**	**89.6**	**93.1**	**96.4**
Freshwater aquaculture	8.6	19.8	36.8	48	49.6	51.3
Marine aquaculture	6.3	14.4	22.8	28.5	30	30.8
Aquaculture total	**14.9**	**34.2**	**59.7**	**76.5**	**79.5**	**82.1**
Total production capture and aquaculture	**101.8**	**125.6**	**149.5**	**166.1**	**172.7**	**178.5**
Utilization						
Human consumption	71.8	98.5	129.2	148.2	152.9	156.4
Human population (billions)	5.4	6.2	7	7.5	7.5	7.6
Fish consumption (kg/person/year)	13.4	15.9	18.4	19.9	20.3	20.5
Non food use	29.9	27.1	20.3	17.9	19.7	22.2

Source: FAO (2020)

Production of fish in Slovakia

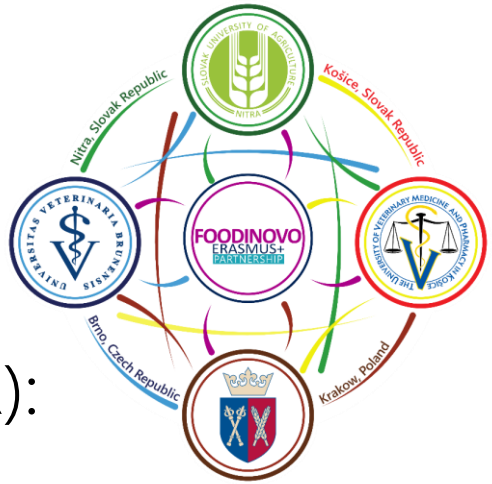
Production of fish in Slovakia



There are registered in Slovakia (Multiannual National Strategic Plan for the Development of Aquaculture in the Slovak Republic for the years 2014 - 2020):

- 499 ponds with an area of 2 219.1 ha.
- 282 cages with a volume of 5 944 m3 for rainbow trout production.
- 494 fences with a total area of 29.6 ha.
- 299 water tanks, weirs and silos with a total volume of 25 098 m^3.
- 204 other water reservoirs which are used for fish farming purposes with a total volume of 15 966 m^3.

Production of fish in Slovakia



In 2021, 210 fish farming facilities are registered in Slovakia (ŠVPS SR):

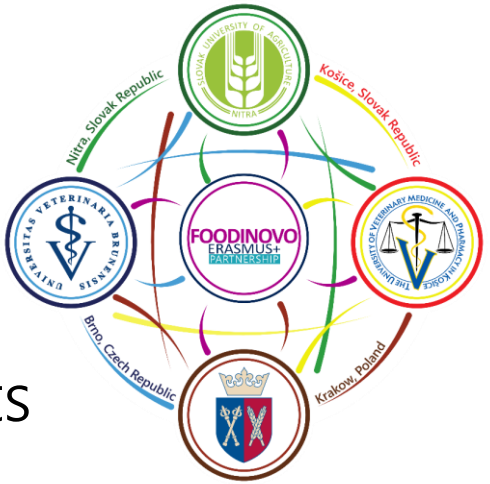
- 81 carp farms.
- 78 salmonid farms.
- 45 carp and salmonid farms.
- 6 farms of other fish species.

Annual production of about 2000 tonnes of fish.

Share of GDP 0.002 %.

Employment of approx. 400 employees in aquaculture and 600 employees in the processing sector.

Processing of fish in Slovakia



In 2021, 36 establishments for processing of fish and fishery products are approved in Slovakia (ŠVPS SR):

- 9 establishments for the processing of fresh fishery products.
- 27 storage establishments. Processing and repackaging of fishery products.

Annual production of approximately 320 tonnes of freshwater fish.

Annual production of approximately 5 200 tonnes of marine fish.

Annual import of approx. 15 000 tonnes of fish and fish products.

Consumption of fish in Slovakia

Development of meat consumption in kg per capita in the Slovak Republic in 2015 - 2019

Meat	2015	2016	2017	2018	2019
Beef and veal	4.3	4.8	5.2	5.2	5.2
Pork	30.9	35.4	35.9	35.4	35.7
Poultry	14.1	16.9	20.2	22.2	26.9
Other types of meat	1.3	1.3	1.5	1.5	1.5
Meat total	**50.6**	**58.4**	**62.8**	**64.3**	**69.3**
Fish	**5.1**	**5.1**	**5.5**	**5.5**	**5.6**

Source: Sitárová. Statistical Office of the Slovak Republic (2020)

Quality of fish

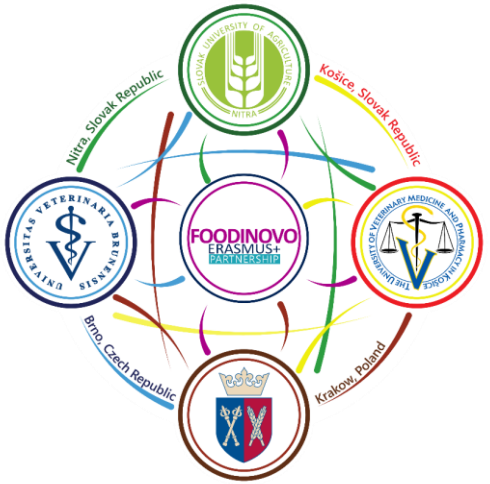
Quality is the sum of the specified characteristics and features of a product which give it the ability to satisfy the specific needs of the consumer.

REGULATION (EC) No 853/2004 laying down specific hygiene rules for food of animal origin

LAW No. 152/1995 Coll. on foodstuffs, as amended

DECREE No 425/2012 of the Slovak Ministry of Agriculture and Rural Development on fishery products and products thereof

Safety of fish



Foods will be considered unsafe if they are:

- harmful to health.
- unfit for human consumption.

REGULATION (EC) No 178/2002 laying down the general principles and requirements of food law and laying down procedures in matters of food safety

Safety of fish

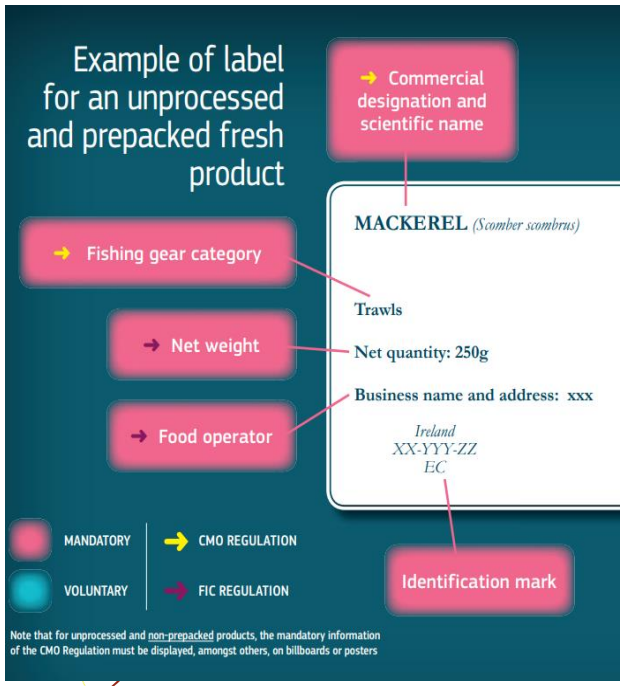
COMMISSION REGULATION (EC) No 2073/2005 on microbiological criteria for foodstuffs

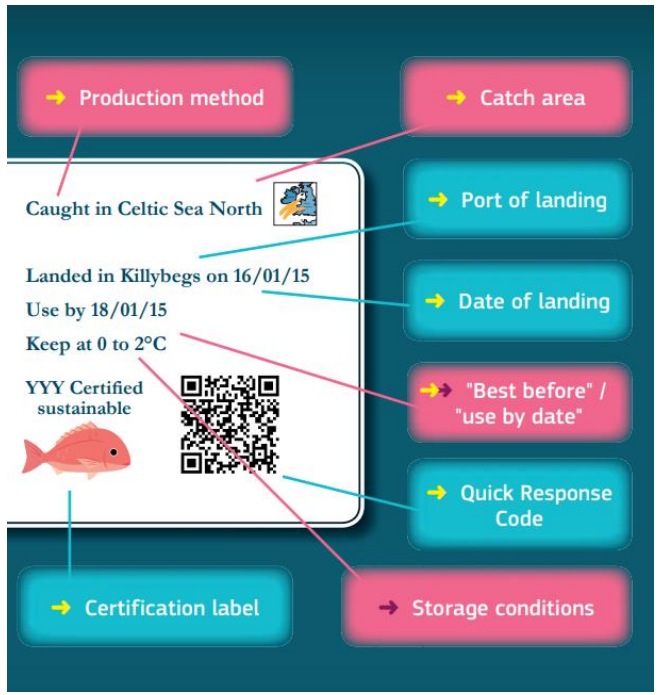
COMMISSION IMPLEMENTING REGULATION (EU) 2019/627 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption (TVB-N)

COMMISSION REGULATION (EU) No 835/2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for polycyclic aromatic hydrocarbons in foodstuffs

Labelling
of fishery and aquaculture products

REGULATION (EU) No 1169/2011 on the provision of food information to consumers
REGULATION (EU) No 1379/2013 on the common organisation of the markets in fishery and aquaculture products





Net quantity: (Net weight)

- This must be expressed in grams or kilograms.
- The **drained net weight** of the food must also be shown where a solid food is in a liquid medium (also frozen or quick-frozen).
- If the food has been glazed, the declared net weight of the food must exclude the glaze. In this case, one of these four possibilities should be indicated on the label (example of 250 g):
  a) Net weight = 250 g and Drained net weight = 250 g
  b) Net weight = Drained net weight = 250 g
  c) Drained net weight = 250 g
  d) Net weight (without glaze) = 250 g

Defrosted:

- In the case of foods that have been frozen before sale and which are sold defrosted, the name of the food must be accompanied by the designation 'defrosted'.
- This information is not necessary for:
  - ingredients present in the final product;
  - foods for which freezing is a technologically necessary step of the production process;
  - foods where defrosting has no negative impact on the safety or quality of the food.

Added water:

- Added water must be shown in the **list of ingredients** in accordance with the requirements of the FIC Regulation.
- For fishery products having the appearance of a cut, joint, slice, portion, fillet or a whole fishery product, the added water must also be shown in the **name of the food** if the added water makes up more than 5% of the weight of the finished product.

'Date of freezing' or 'Date of first freezing':

- This requirement only applies to **unprocessed** products.
- The date must be indicated as follows: 'Frozen on day/month/year'.

Labelling

of fishery and aquaculture products

SUMČEK OMEGA

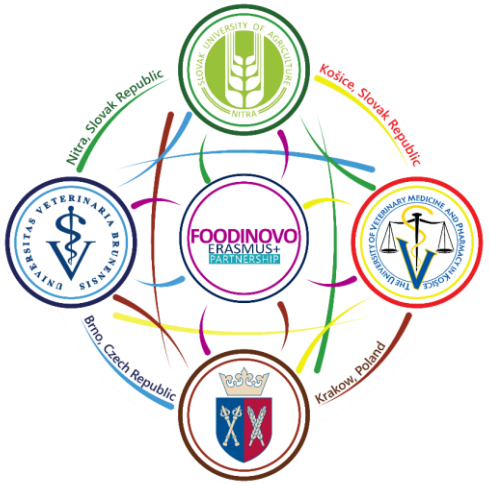
REGULATION (EC) No 1924/2006 on nutrition and health claims made on foods

COMMISSION REGULATION (EU) No 116/2010 amending Regulation (EC) No 1924/2006 of the European Parliament and of the Council as regards the list of nutrition claims

"SOURCE OF OMEGA-3 FATTY ACIDS" a claim that a food is a source of omega-3 fatty acids and any claim which may have the same meaning for the consumer. may only be made if the product contains at least 40 mg of the sum of eicosapentaenoic acid and docosahexaenoic acid per 100 g and per 100 kcal.

"HIGH IN OMEGA-3 FATTY ACIDS" a claim that a food is high in omega-3 fatty acids. and any claim which may have the same meaning for the consumer. may only be made if the product contains at least 80 mg of the sum of eicosapentaenoic acid and docosahexaenoic acid per 100 g and per 100 kcal.

Selected technological processes of fish processing



1. Freezing of fish
2. Glazing of fish
3. Use of antioxidants in fish glazing
4. Smoking of fish

Freezing of fish

Determination of the chemical composition of fresh and frozen rainbow trout (*Oncorhynchus mykkis*) (basic chemical composition and fatty acid profile)

Slov Vet Res 2014; 51 (2):
UDC 597.552.5:637.56:641.1:664.8.037.59

Original Scientific Article

COMPARISON OF THE CHEMICAL COMPOSITION AND NUTRITIONAL VALUES OF FRESH AND FROZEN RAINBOW TROUT

Peter Popelka[1]*, Slavomír Marcinčák[1], Iveta Maskaľová[1], Lucia Guothová[2], Milan Čertík[2]

[1]University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 041 81 Košice, [2]Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Radlinského 9, 812 37 Bratislava, Slovak Republic

Component	Fresh fillets			Frozen fillets		
	g.100 g^{-1}	Kcal	kJ	g.100 g^{-1}	Kcal	kJ
Protein	18.77	75.08	319.09	18.35	73.4	311.95
Fat	2.74	24.66	101.38	2.99	26.91	110.63
Carbohydrates	1.65	6.6	28.05	1.45	5.8	24.65
Energy value in 100 g		106.34	448.52		106.11	447.23

Fatty acids	Formulas	Value (%)
Myristic acid	C 14:0	3.2
Pentadecanoic acid	C 15:0	0.3
Palmitic acid	C 16:0	13.0
Palmitoleic acid	C 16:1-9c	5.1
Hexadecadienoic acid	C 16:2-9c,12c	0.8
Heptadecanoic acid	C 17:0	0.3
Stearic acid	C 18:0	3.0
Oleic acid	C 18:1-9c	21.4
Cis-vaccenic acid	C 18:1-11c	3.0
Linoleic acid n-6	C 18:2-9c,12c	14.5
Alpha linolenic acid n-3	C 18:3-6,9,12c	0.4
Gamma linolenic acid n-6	C 18:3-9,12,15c	2.0
Octadecatetraenoic acid n-3	C 18:4-6,9,12,15c	1.2
Eicosenoic acid	C 20:1-11c	4.8
Eicosadienoic acid n-6	C 20:2-11c,14c	0.8
Dihomo-linolenic acid n-6	C 20:3-8,11,14c	0.4
Arachidonic acid n-6	C 20:4-5,8,11,14c	0.8
Eicosatrienoic acid n-3	C 20:3-11,14,17c	0.2
Eicosatetraenoic acid n-3	C 20:4-8,11,14,17c	0.8
Eicosapentaenoic acid n-3	C 20:5-5,8,11,14,17c	4.5
Docosanoic acid	C 22:0	0.1
Erucic acid	C 22:1-13c	3.7
Docosadienoic acid n-6	C 22:2-13c,16c	0.1
Docosapentaenoic acid n-3	C 22:5-7,10,13,16,19c	1.7
Docosahexaenoic acid n-3	C 22:6-4,7,10,13,16,19c	12.7
Tetracosenoic acid	C 24:1	0.0

Freezing of fish

Monitoring the effect of repeated freezing on muscle quality of rainbow trout

ACTA VET. BRNO 2014, 83: 157–161; doi:10.2754/avb201483020157

Comparison of chemical, microbiological and histological changes in fresh, frozen and double frozen rainbow trout (*Oncorhynchus mykiss*)

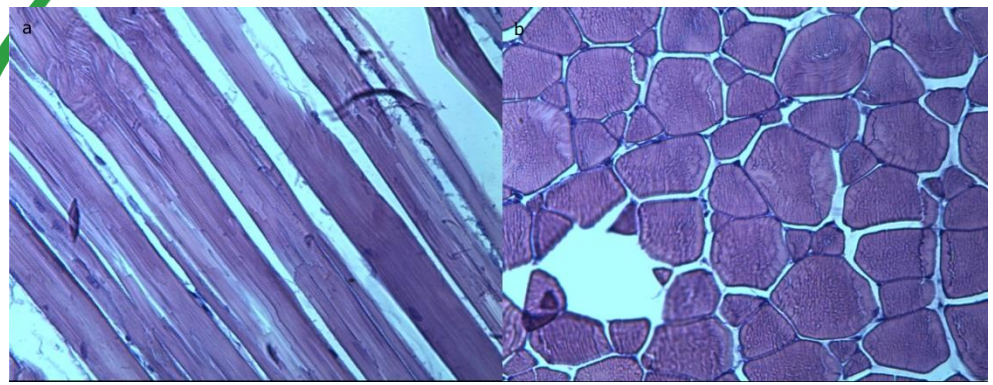
Peter Popelka[1], Jozef Nagy[1], Monika Pipová[1], Slavomír Marcinčák[1], Ľudovít Lenhardt[2]

University of Veterinary Medicine and Pharmacy in Košice, [1]Department of Food Hygiene and Technology, [2]Department of Pathological Anatomy and Pathological Physiology, Košice, Slovak Republic

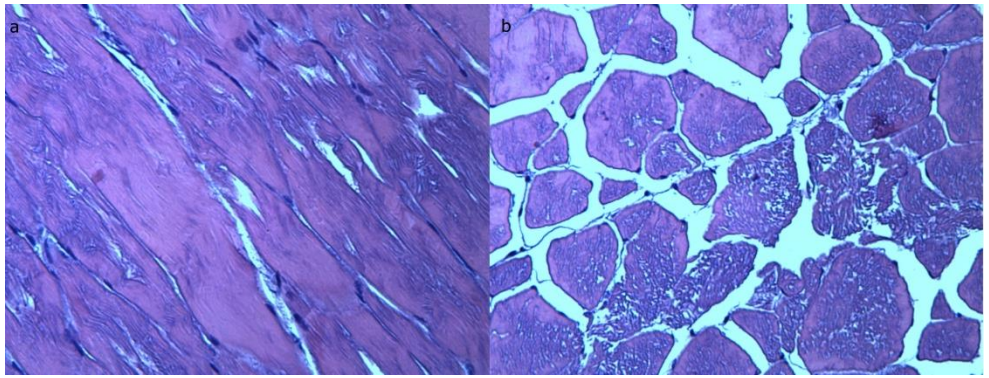
Received April 4, 2013
Accepted January 23, 2014

- Determination of chemical (chemical composition. TVB-N), microbiological (CPM, *Enterobacteriaceae*, psychrotrophic bacteria) and sensory parameters.
- Determination of histological changes in rainbow trout muscle.

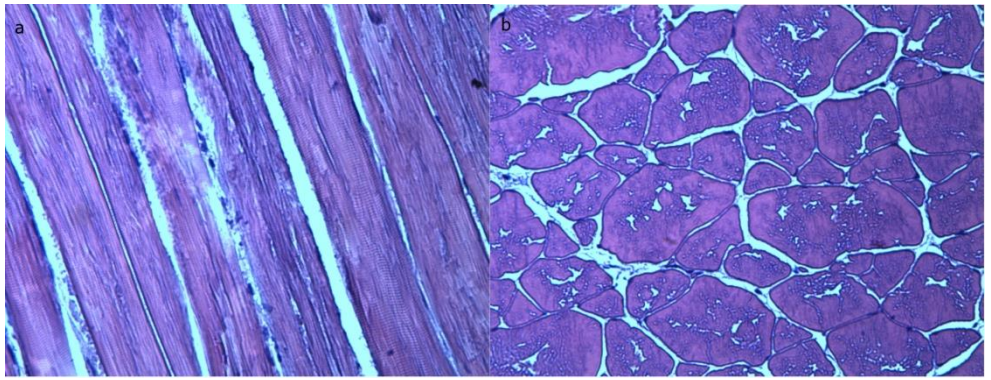
Freezing of fish



Longitudinal and transverse section through the dorsal through the muscle of fresh trout (400x)



Longitudinal and transverse sections through the dorsal muscle of twice-frozen trout (400x)



Longitudinálny a priečny rez dorzálnou svalovinou zmrazených pstruhov (400x)

Glazing of fish

ACTA VET. BRNO 2011, 80: 299–304; doi:10.2754/avb201180030299

The effect of glaze on the quality of frozen stored Alaska pollack (*Theragra chalcogramma*) fillets under stable and unstable conditions

Peter Žoldoš[2], Peter Popelka[1], Slavomír Marcinčák[1], Jozef Nagy[1], Lýdia Mesarčová[1], Monika Pipová[1], Pavlína Jevinová[1], Alena Nagyová[3], Pavel Maľa[1]

[1]Department of Food Hygiene and Technology, University of Veterinary Medicine and Pharmacy in Košice, Slovak Republic
[2]Mraziarne Poprad, Slovak Republic
[3]Department of the Environment, Veterinary Legislation and Economics, University of Veterinary Medicine and Pharmacy in Košice, Slovak Republic

Received March 31, 2010
Accepted April 6, 2011

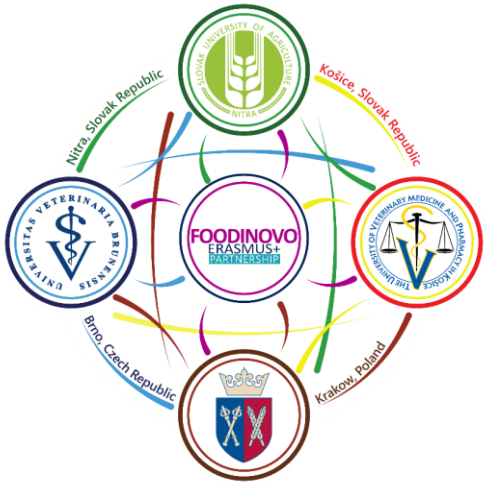
ACTA VET. BRNO 2012, 81: 397–402; doi:10.2754/avb201281040397

The effect of glaze and storage temperature on the quality of frozen mackerel fillets

Peter Popelka, Oľga Luptáková, Slavomír Marcinčák, Jozef Nagy, Lýdia Mesarčová, Alena Nagyová

University of Veterinary Medicine and Pharmacy in Košice, Department of Food Hygiene and Technology, Košice, Slovak Republic

Received May 4, 2012
Accepted August 13, 2012



Effect of glazing and storage temperature on the quality of frozen Alaska pollock (*Theragra chalcogramma*) fillets

Effect of glazing and storage temperature on the quality of frozen mackerel (*Scomber scombrus*) fillets

- Determination of the amount of glaze.
- Determination of chemical (chemical composition, TVB-N, TBARS) and microbiological (CPM, *Enterobacteriaceae*, psychrotrophic bacteria) parameters.
- Sensory evaluation.

Glazing of fish

Glaze percentage (%) in mackerel fillets (mean±SD)

Sample	Month of storage						
	0	1.	2.	3.	4.	5.	6
CS	$1.11^{a1} \pm 0.01$	$2.53^{a2} \pm 0.12$	$2.11^{a1} \pm 0.08$	$3.45^{a2} \pm 0.31$	$3.28^{a2} \pm 0.46$	$3.65^{a23} \pm 0.38$	$4.86^{a3} \pm 0.61$
GS	$9.04^{b} \pm 0.04$	$9.02^{c} \pm 0.23$	$9.24^{bc} \pm 0.28$	$9.93^{b} \pm 0.43$	$9.27^{b} \pm 0.36$	$9.46^{b} \pm 0.58$	$9.38^{b} \pm 0.45$
CU	$1.11^{a1} \pm 0.01$	$4.59^{b2} \pm 0.38$	$5.15^{b23} \pm 0.50$	$6.01^{b3} \pm 0.49$	$6.47^{b3} \pm 0.31$	$6.32^{b3} \pm 0.26$	$6.82^{b4} \pm 0.39$
GU	$9.04^{b1} \pm 0.04$	$9.20^{c1} \pm 0.31$	$9.53^{c1} \pm 0.33$	$11.62^{c2} \pm 0.83$	$11.41^{c2} \pm 0.48$	$11.54^{c2} \pm 0.63$	$11.65^{c2} \pm 0.59$

^{a,b,c} within rows, different superscript letters indicate significant differences ($P < 0.05$)
^{1,2,3} within columns, different superscript numbers indicate significant differences ($P < 0.05$)
CS - control unglazed fillets stored under stable freezing conditions, GS - glazed fillets stored under stable freezing conditions, CU - control unglazed fillets stored under unstable freezing conditions, GU - glazed fillets stored under unstable freezing conditions

Chemical composition of mackerel fillets (%) (mean±SD)

Sample	Moisture	Protein	Fat
CS	60.16 ± 3.917	16.50 ± 0.549	21.59 ± 4.434
GS	60.15 ± 4.181	16.63 ± 0.670	22.50 ± 4.789
CU	60.27 ± 1.552	16.68 ± 0.689	21.83 ± 2.133
GU	60.08 ± 1.840	16.78 ± 1.084	22.26 ± 2.684

CS - control unglazed fillets stored under stable freezing conditions, GS - glazed fillets stored under stable freezing conditions, CU - control unglazed fillets stored under unstable freezing conditions, GU - glazed fillets stored under unstable freezing conditions

Sensory evaluation of mackerel fillets after 6 months of storage using a 5-point method (maximum 25 points) (mean± SD)

Sample	Boiling method	Frying method
CS	21.50 ± 1.05	21.67 ± 1.75^{ab}
GS	21.33 ± 2.34	22.50 ± 0.55^{a}
CU	19.83 ± 1.47	19.67 ± 1.51^{b}
GU	20.33 ± 1.63	22.17 ± 1.17^{a}

Within rows, different superscript letters indicate significant differences ($P < 0.05$)
CS - control unglazed fillets stored under stable freezing conditions, GS - glazed fillets stored under stable freezing conditions, CU - control unglazed fillets stored under unstable freezing conditions, GU - glazed fillets stored under unstable freezing conditions

Oxidative changes (expressed as amount of MDA in $mg.kg^{-1}$) in mackerel fillets (mean±SD)

Sample	Month of storage						
	0	1	2	3	4	5	6
CS	$7.28^{a1} \pm 0.59$	$7.45^{a1} \pm 0.48$	$10.88^{a2} \pm 1.43$	$11.16^{a2} \pm 0.41$	$12.86^{b2} \pm 1.27$	$13.01^{a2} \pm 0.73$	$13.75^{a2} \pm 0.63$
GS	$6.59^{a1} \pm 0.038$	$7.44^{a1} \pm 0.83$	$9.05^{a2} \pm 0.26$	$9.78^{a2} \pm 0.51$	$10.98^{a3} \pm 0.56$	$11.35^{a3} \pm 1.04$	$11.79^{a3} \pm 0.80$
CU	$7.28^{a1} \pm 0.59$	$8.58^{a1} \pm 0.63$	$13.52^{b2} \pm 1.32$	$14.53^{b2} \pm 0.72$	$18.56^{c3} \pm 1.64$	$18.03^{b3} \pm 1.21$	$19.25^{b3} \pm 1.10$
GU	$6.59^{a1} \pm 0.04$	$8.14^{a1} \pm 0.33$	$11.58^{a2} \pm 0.69$	$12.22^{a2} \pm 1.14$	$13.94^{b3} \pm 0.74$	$14.73^{b3} \pm 1.02$	$15.68^{b3} \pm 1.11$

^{a,b,c} within rows, different superscript letters indicate significant differences ($P < 0.05$)
^{1,2,3} within columns, different superscript numbers indicate significant differences ($P < 0.05$)
CS - control unglazed fillets stored under stable freezing conditions, GS - glazed fillets stored under stable freezing conditions, CU - control unglazed fillets stored under unstable freezing conditions, GU - glazed fillets stored under unstable freezing conditions

Glazing of fish

Effect of antioxidants

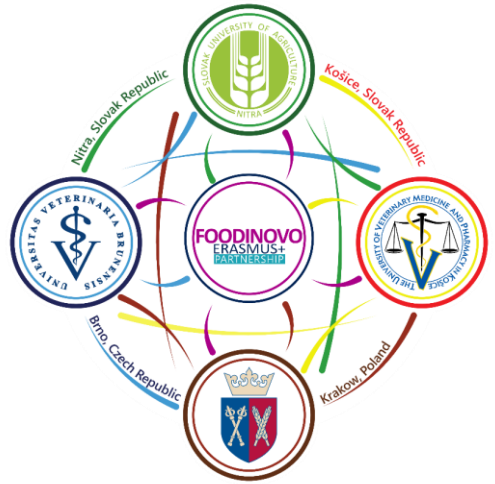
Acta Alimentaria, Vol. 42 (2), pp. 236–244 (2013)
DOI: 10.1556/AAlim.42.2013.2.11

EFFECT OF GLAZE AND SELECTED HERBAL EXTRACTS ON LIPID OXIDATION AND SENSORY PROPERTIES OF FROZEN ATLANTIC HERRINGS (*CLUPEA HARENGUS* L.)

L. MESARČOVÁ[a], S. MARCINČÁK[a*], J. NAGY[a], P. POPELKA[a], M. BAČA[a], P. JEVINOVÁ[a] and D. MARCINČÁKOVÁ[b]

[a] Department of Food Hygiene and Technology, University of Veterinary Medicine and Pharmacy in Kosice, Komenského 73, 041 81 Košice. The Slovak Republic
[b] Department of Pharmacology and Toxicology, University of Veterinary Medicine and Pharmacy in Kosice, Komenského 73, 041 81 Košice. The Slovak Republic

(Received: 24 July 2012; accepted: 10 September 2012)



Glazing of herring fillets (*Clupea harengus*) with the addition of plant extracts:

- Hawthorn (Crataegus oxyacantha) extract (0.3 %)
- Agrimony (Agrimonia eupatoria) extract (0.3 %)

- Determination of antioxidant activity and total phenolic content of hawthorn and agrimony extracts
- Oxidative stability of lipids (TBARS) expressed as MDA (mg/kg)
- Determination of fatty acid profile
- Sensory evaluation

Glazing of fish
Effect of antioxidants

Antioxidant activity and total phenolic content of hawthorn and agrimony extracts (mean ±SD)

	Concentration (mg ml^{-1})	Antioxidant activity (%)	Total phenolic content (mg g^{-1})
Hawthorn	3.0	90.6±2.3	20.8±3.00^{a}
Agrimony	3.0	91.1±1.6	33.9±0.80^{b}

^{a,b}: Mean values with a different letter in column are significantly different at P<0.05.

Chemical composition of herring fillets (mean ±SD)

	Water (%)	Dry matter (%)	Fat (%)
C	68.90±0.32	31.10±0.32	12.82±0.39
G	69.95±0.43	30.05±0.43	11.67±0.26
GH	70.05±0.22	29.95±0.22	11.84±0.31
GA	70.45±0.38	29.55±0.38	11.48±0.42

Lipid oxidation (expressed as amount of MDA in mg.kg^{-1}) in herring fillets (mean ± SD)

Month of storage	C	G	GA	GH
0	9.72±1.03^{a1}	7.63±0.50^{a1}	7.06±1.01^{a1}	6.89±0.62^{a1}
2	12.20±0.41^{a2}	11.06±0.90^{ab2}	10.90±0.35^{b2}	9.24±0.58^{b2}
4	17.16±0.69^{a3}	15.50±0.29^{b3}	12.76±0.61^{c3}	12.58±0.63^{c3}
6	19.67±0.73^{a4}	17.27±0.66^{b4}	14.17±0.28^{c3,4}	15.12±0.96^{c4}
8	20.17±0.67^{a4}	18.17±0.54^{b4}	14.55±0.69^{c4}	15.25±0.87^{c4}

^{1,2,3,4}: Mean values with different letters within columns are significantly different at P<0.05.
^{a,b,c}: Mean values with different letters within rows are significantly different at P<0.05
C: Unglazed; G: glazed with water; GH: glazed with 0.3% hawthorn; GA: glazed with 0.3% agrimony

Sensory evaluation of frozen herring fillets (-18 °C) after 8 months of storage (mean ± SD)

Samples	Boiling	Frying
C	15.4±2.2	14.85±2.3^{b}
G	15.6±2.5	17.50±1.7^{a}
GH	15.2±2.3	16.95±1.9^{a}
GA	15.8±2.8	17.70±1.8^{a}

Smoking of fish

ACTA VET. BRNO 2021, 90: 000–000; https://doi.org/10.2754/avb202190010000

Influence of smoking and packaging methods on physicochemical and microbiological quality of smoked mackerel (*Scomber scombrus*)

Peter Popelka[1], Monika Šuleková[1], Pavlína Jevinová[1], Boris Semjon[1], Terézia Hudáková[2], Tatiana Klempová[3], Milan Čertík[3], Pavol Roba[1], Matúš Várady[1]

[1]University of Veterinary Medicine and Pharmacy in Košice, Košice, Slovakia
[2]Pavol Jozef Šafárik University in Košice, Faculty of Medicine, Košice, Slovakia
[3]Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Bratislava, Slovakia

Received February 17, 2020
Accepted

Effect of smoking and different packaging methods on the quality of smoked mackerel (*Scomber scombrus*)

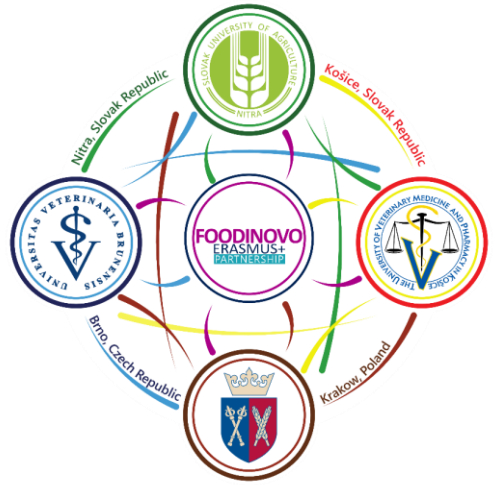
- Determination of chemical (chemical composition, TVB-N, TBARS) parameters.
- Determination of fatty acid profile.
- Determination of microbiological (CPM, *Enterobacteriaceae*, psychrotrophic bacteria) parameters.
- Determination of histamine and PAHs.

Smoking of fish

Effect of smoking on the fatty acid profile (%) in raw and smoked mackerel (mean ± SD)

Fatty acids	Raw mackerel	Smoked mackerel
Lauric acid, C12:0	0.08 ± 0.00	0.07 ± 0.01
Myristic acid, C14:0	9.85 ± 0.27	8.94 ± 1.18
Palmitic acid, C16:0	17.73 ± 0.21	18.48 ± 0.58
Palmitoleic acid, C16:1-7c	0.36 ± 0.01	0.34 ± 0.016
Palmitoleic acid, C16:1-9c	4.89 ± 0.08	4.99 ± 0.69
Stearic acid, C18:0	3.89 ± 0.07	3.50 ± 0.30
Oleic acid, C18:1-9c	14.09 ± 0.32[a]	11.65 ±0.99[b]
Vaccenic acid, C18:1-11c	2.79 ± 0.04	2.46 ± 0.07
Linoleic acid, C18:2-9c, 12c	3.10 ± 0.04	2.75 ± 0.16
Gamma-linolenic acid, C18:3-6c, 9c, 12c	0.29 ± 0.00	0.30 ± 0.02
Alpha-linolenic acid, C18:3-9c, 12c, 15c	2.42 ± 0.01	2.46 ± 0.26
Stearidonic acid, C18:4-6c, 9c, 12c, 15c	7.49 ± 0.03	6.35 ± 1.05
C20:0	0.37 ± 0.01	0.30 ± 0.02
C20:1-11c	1.31 ± 0.08	1.06 ± 0.23
C20:2-11c,14c	0.42 ± 0.01	0.41 ± 0.05
Dihomo-gamma-linolenic acid, C20:3-8c, 11c, 14c	0.19 ± 0.00	0.19 ± 0.01
Arachidonic acid, C20:4-5c, 8c, 11c, 14c	0.99 ± 0.04[a]	0.76 ± 0.14[b]
C20:3-11c,14c,17c	0.31 ± 0.01	0.27 ± 0.01
Eicosatetraenoic acid, C20:4-8c, 11c, 14c, 17c, n3	1.60 ± 0.02	1.57 ± 0.12
Eicosapentaenoic acid, C20:5-5c, 8c, 11c, 14c, 17c	10.04 ± 0.22	10.79 ± 0.16
C22:4-7c,10c,13c,16c	0.76 ± 0.01	0.70 ± 0.08
Docosapentaenoic acid, C22:5-4c, 7c, 10c, 13c, 16c	0.47 ± 0.01	0.44 ± 0.08
Docosapentaenoic acid, C22:5-7c, 10c, 13c, 16c, 19c	2.08 ± 0.04	2.15 ± 0.05
Docosahexaenoic acid, C22:6-4c, 7c,10c,13c, 16c,19c	14.51 ± 0.48[a]	19.07 ± 3.62[b]
∑ SFA	31.92 ± 0.42	31.29 ± 0.44
∑ MUFA	23.45 ± 0.39	20.50 ± 1.56
∑ PUFA	44.64 ± 0.68	48.21 ± 1.97
∑ n-3 PUFA	38.43 ± 0.65	42.66 ± 2.06
∑ n-6 PUFA	6.21 ± 0.04	5.56 ± 0.09

[a,b] - significant differences in rows ($P < 0.05$); SFA - saturated fatty acids; MUFA - monounsaturated fatty acids; PUFA - polyunsaturated fatty acids



Effect of smoking on chemical composition. TBARS (expressed as MDA) and TVB-N in raw and smoked mackerel (mean ± SD)

	Protein (%)	Fat (%)	MDA (ng/kg)	TVB-N (mg N/100 g)
Raw mackerel	15.79 ± 1.99	22.58 ± 1.87	964.57 ± 130.9[a]	8.52 ± 1.9
Smoked mackerel	18.20 ± 2.33	24.48 ± 1.45	655.21 ± 119.1[b]	11.92 ± 3.6

[a,b] - significant differences in columns ($P < 0.05$); MDA - malondialdehyde; TVB-N - total volatile basic nitrogen

Probiotics of fish nutrition


Aquaculture 469 (2017) 1–8

Contents lists available at ScienceDirect

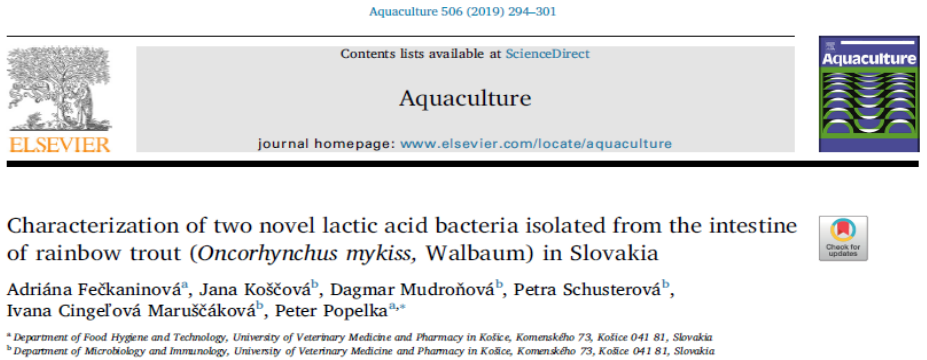
Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture

The use of probiotic bacteria against *Aeromonas* infections in salmonid aquaculture

Adriána Fečkaninová [a], Jana Koščová [b], Dagmar Mudroňová [b], Peter Popelka [a,*], Júlia Toropilová [a]

[a] Department of Food Hygiene and Technology, University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 041 81 Košice, Slovak Republic
[b] Department of Microbiology and Immunology, University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 041 81 Košice, Slovak Republic


Aquaculture 506 (2019) 294–301

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture

Characterization of two novel lactic acid bacteria isolated from the intestine of rainbow trout (*Oncorhynchus mykiss*, Walbaum) in Slovakia

Adriána Fečkaninová[a], Jana Koščová[b], Dagmar Mudroňová[b], Petra Schusterová[b], Ivana Cingeľová Maruščáková[b], Peter Popelka[a,*]

[a] Department of Food Hygiene and Technology, University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, Košice 041 81, Slovakia
[b] Department of Microbiology and Immunology, University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, Košice 041 81, Slovakia

- Isolation and identification of LAB strains from the GIT of rainbow trout.
- *In vitro* and *in vivo* testing of the ability of LAB to colonize the GIT of rainbow trout and Atlantic salmon.
- *In vitro* and *in vivo* antagonism testing against selected salmonid pathogens (*Aeromonas salmonicida* and *Yersinia ruckeri*).
- Development of technological procedure and preparation of feed supplemented with selected LAB strains.
- Deposit of 2 LAB strains for patent purposes in Czech microorganism collection, Faculty of Science, Masaryk University in Brno

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Financované Európskou úniou. Vyjadrené názory a postoje sú názormi a vyhláseniami autora(-ov) a nemusia nevyhnutne odrážať názory a stanoviská Európskej únie alebo Európskej výkonnej agentúry pre vzdelávanie a kultúru (EACEA). Európska únia ani EACEA za ne nepreberajú žiadnu zodpovednosť.

FOODINOVO | 2020-1-SK01-KA203-078333

Spolufinancované z programu Európskej únie Erasmus+

Co-funded by the Erasmus+ Programme of the European Union

This work was co-funded by the Erasmus+ Programme of the European Union

Innovation of the structure and content of study programs profiling food study fields with a view to digitizing teaching

Táto publikácia bola spolufinancovaná programom Európskej Únie Erasmus+

Inovácia štruktúry a obsahového zamerania študijných programov profilujúcich potravinárske študijné odbory s ohľadom na digitalizáciu výučby

FOODINOVO | 2020-1-SK01-KA203-078333

Spolufinancované z programu Európskej únie Erasmus+

Co-funded by the Erasmus+ Programme of the European Union