Effect of Substances of Natural Origin in Chicken Nutrition on The Health Safety and Fat Quality of Produced Meat

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

Fats in human nutrition

- **Fats** - a group of organic compounds found in living organisms containing ester-linked fatty acids with three or more carbon atoms
- **Properties** – insolubility in water and solubility in polar solvents
- **Fats in foods** – mainly triacylglycerols (95 – 98 %), fosfolipids and sterols
  - Natural basic component of food
  - added as an additive in the processing of many foods.
- **The quality and type of fat affects the appearance, taste, energy and nutritional value of foods**

Properties of fats in food

Positive properties of fats

- The main source of energy in food (9 of kcal.g^{-1})
- Source of essential fatty acids (LA, ALA 2 – 10 g, DPA, DHA)
- Source of lipophilic vitamins (A, D, E, K)
- They affect the organoleptic properties of foods (texture, texture, taste, aroma, colour)

Negative properties of fats

- Excessive energy intake (overweight, civilization diseases)
- Intake of additives (stabilisers, emulsifiers, colouring agents, synthetic antioxidants, etc.)
- Rapid decomposition (hydrolysis, lipid oxidation)

Poultry farming

- One of the most important sections of livestock production

- Broiler chicken
  - rapid intensity of growth
  - profitability of breeding
  - efficiency of production
  - the palatability and popularity of the meat by consumers

Meat of broiler chickens

- **Meat** – concentrated source of nutritiens, essential for optimal body growth
- **Meat quality**– is evaluated on the basis of its nutritional, sensory, technological and hygienic properties
- **Broilers chickens** – mainly breast and thight meat
  - Low in fat and cholesterol content and relatively high in PUFA
  - High content of proteins, minerals and vitamins
  - Very good taste of meat
  - Easy digestibility of meat

	Water content (%)	Proteins (%)	Fat (%)
Breast	73,0 – 75,5	20,0 – 23,0	2,0 – 4,15
Thigh meat	70,3 – 75,6	17,9 – 19,5	5,9 – 9,5

Fat quality of broiler chickens

- **Intracellular fat**- fosfolipids a lipoproteins
- **Extracellular fat**- intermuscular, subcutaneous and cavity fat
- **Fat is stored** – under the skin and inside the body (cavity), in the muscles it is significantly lower
- Broiler chicken fat contains **more unsaturated than saturated fatty acids (MK)**
- The dominant fatty acid is oleic acid
- **Intravital effects afecting the fat content of chicken**
  - Breed and genetics
  - Sex
  - Rearing conditions and stress
  - Nutrition of chickens

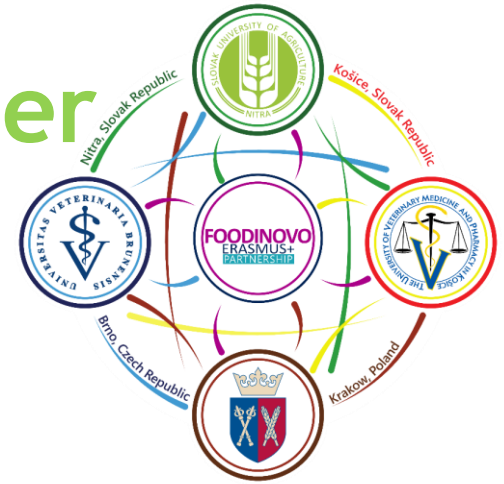
Chicken nutrition and quality of fats

- The quality and fat composition of the meat is influenced by the feed.
- Feeding of poultry and pigs the feed with a higher proportion of essential polyunsaturated FAs (PUFAs) is a simple way to increase the amount of these PUFAs in the adipose tissue of the animals
- Enriching meat with PUFAs will increase the biological value - a significant benefit for human health
- The safest and most effective way to address the problem of inadequate dietary intake of essential essential PUFAs
- Chicken meat is preferable for it low price – new components (additives) can not negatively influence production parameters and the price of meat.

Feed additives in broiler nutrition

- **Vegetable and animal oils** (linseed oil, linseed oil, fish oil)
- **Plants and their extracts** (Melissa, Agrimony, Clove, Oregano, Rosemary)
- **Humic substances** (improving of health status of chicken)
- **Fermented products** (source of microbial PUFAs)

Oils and performance parameters of broiler chickens



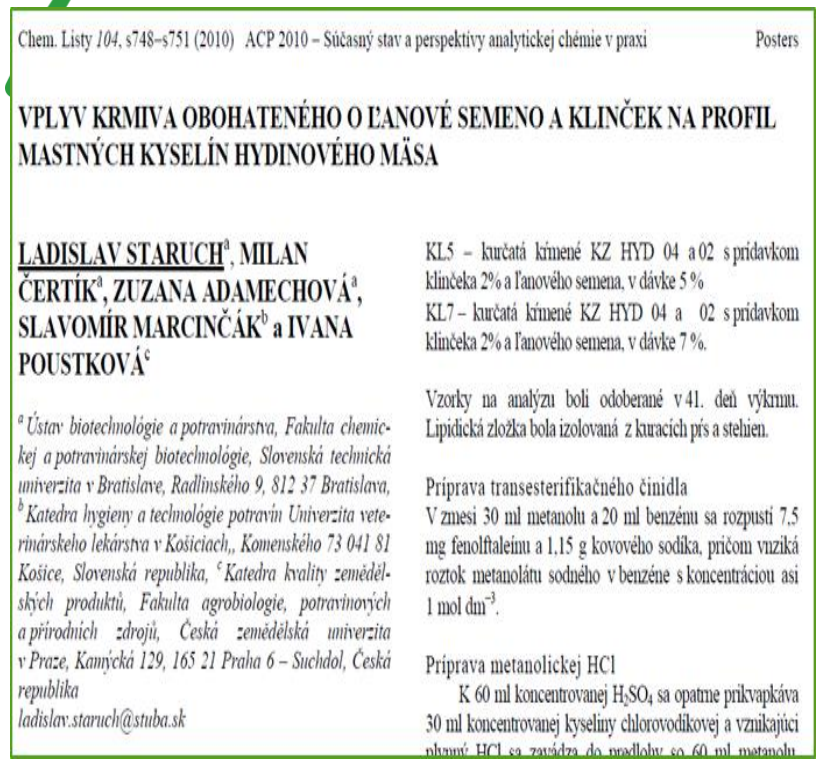
Vegetable oils and seeds

- Sunflower pomace and oil – source of linoleic acid
- Soya, canola, olive oils – source of oleic, linoleic, alfa-linolenic acids
- Linseed oil, seeds and pomace – source of alfa-linolenic acid

Fish oil, seafood – source of DPA, DHA fatty acids

- Fish oils increased significantly content of PUFAs and improved the ratio n-3/n-6 PUFAs in produced meat
- Higher feed price, deterioration of production parameters
- The need to find a suitable combination of feed additives for improvement of performance parameters of chicken

Oils and fatty acid profile of chicken meat



Chem. Listy *104*, s748–s751 (2010) ACP 2010 – Súčasný stav a perspektívy analytickej chémie v praxi Posters

VPLYV KRMIVA OBOHATENÉHO O ĽANOVÉ SEMENO A KLINČEK NA PROFIL MASTNÝCH KYSELÍN HYDINOVÉHO MÄSA

LADISLAV STARUCH[a], MILAN ČERTÍK[a], ZUZANA ADAMECHOVÁ[a], SLAVOMÍR MARCINČÁK[b] a IVANA POUSTKOVÁ[c]

[a] *Ústav biotechnológie a potravinárstva, Fakulta chemickej a potravinárskej biotechnológie, Slovenská technická univerzita v Bratislave, Radlinského 9, 812 37 Bratislava,* [b] *Katedra hygieny a technológie potravín Univerzita veterinárskeho lekárstva v Košiciach,, Komenského 73 041 81 Košice, Slovenská republika,* [c] *Katedra kvality zemědělských produktů, Fakulta agrobiologie, potravinových a přírodních zdrojů, Česká zemědělská univerzita v Praze, Kamýcká 129, 165 21 Praha 6 – Suchdol, Česká republika*
ladislav.staruch@stuba.sk

KL5 – kurčatá krmené KZ HYD 04 a 02 s prídavkom klinčeka 2% a ľanového semena, v dávke 5 %
KL7 – kurčatá krmené KZ HYD 04 a 02 s prídavkom klinčeka 2% a ľanového semena, v dávke 7 %.

Vzorky na analýzu boli odoberané v 41. deň výkrmu. Lipidická zložka bola izolovaná z kuracích pŕs a stehien.

Príprava transesterifikačného činidla
V zmesi 30 ml metanolu a 20 ml benzénu sa rozpustí 7.5 mg fenolftaleínu a 1,15 g kovového sodíka, pričom vzniká roztok metanolátu sodného v benzéne s koncentráciou asi 1 mol dm^{-3}.

Príprava metanolickej HCl
K 60 ml koncentrovanej H_2SO_4 sa opatrne prikvapkáva 30 ml koncentrovanej kyseliny chlorovodíkovej a vznikajúci plynný HCl sa zavádza do predlohy so 60 ml metanolu

SOURCE: STARUCH, L., ČERTÍK, M., ADAMECHOVÁ, Z., MARCINČÁK, S., POUSTKOVÁ, I.: EFFECT OF FEED ENRICHED WITH LINSEED AND CLOVES ON THE FATTY ACID PROFILE OF POULTRY MEAT. CHEMICKÉ LISTY, 104, 16, 2010, s748 - s751.

Fatty acid [%, w/w]	Breast meat					
	Control	Control	KL5	KL5	KL7	KL7
	breast	thigh	breast	thigh	breast	thigh
C 16:0, PA	21.95	21.62	20.83	20.77	22.70	20.64
C 18:0, SA	5.57	5.31	6.57	5.36	5.61	6.5
C 18:1, OA	40.25^{a}	40.27^{A}	35.54^{c}	39.63	39.50^{b}	38.70^{B}
C 18:2, LA	18.87	19.38	21.11	18.43	16.44	19.67
C 18:3, GLA	0.20	0.16	0.20	0.15	0.17	0.18
C 18:3, ALA	1.56^{c}	1.44^{C}	4.87^{a}	4.28^{A}	3.15^{b}	4.13^{B}
C 20:4, ARA	0.40	0.43	0.77	0.28	0.43	0.36
C 20:5, EPA	0.06	0.08	0.31	0.09	0.00	0.17
C 22:5, DPA	0.09^{c}	0.09	0.36^{a}	0.14	0.19^{b}	0.18
C 22:6, DHA	0.06^{b}	0.04	0.23^{a}	0.09	0.10^{b}	0.09
Sum of saturated FA	28.35	27.66	28.20	26.83	29.7	27.49
Sum of unsaturated FA	71.65	72.34	71.81	73.17	70.93	72.51
Sum of essential FA	2.50^{c}	2.39^{B}	6.98^{a}	5.17^{A}	4.23^{b}	5.26^{A}

KL5: linseed 5% and clove 2%; KL7: linseed 7% and clove 2%, PA-palmitic, SA-kys. stearic, OA– oleic, LA-linoleic, GLA– gama-linolenic, ALA–alpha-linolenic, ARA–arachidonic, EPA– eicosapentaenoic, DPA– docosapentaenoic, DHA–docosahexaenoic acid. FA- fatty acids.

Oils and safety of produced meat

- Higher proportion of PUFAs - lower meat stability
- Linseed oil and seeds - higher oxidation of stored meat, shortening storage time
- Fish oil - fishy smell, oxidation, change in sensory properties and storage of meat
- Changes in storage method - vacuum packing, protective atmosphere, addition of antioxidants to feed (vitamin E, plant extracts)

Determination of lipid oxidation (presented as a malondialdehyde concentration) of thigh muscle during storage (4°C, 14th days)

	1. deň	7. deň	14. deň
	Malondialdehyde ($mg.kg^{-1}$)		
Kontrola	$0,217 \pm 0,024$	$0,402 \pm 0,094^{b}$	$0,715 \pm 0,081^{a}$
Klinček +ľan 5%	$0,226 \pm 0,057$	$0,415 \pm 0,035^{b}$	$0,952 \pm 0,097^{b}$
Klinček +ľan 7%	$0,309 \pm 0,074$	$0,588 \pm 0,030^{a}$	$1,28 \pm 0,139^{c}$

Kontrola: control; Klinček+ľan5%: linseed 5% and clove 2%; Klinček+ľan5%: linseed 7% and clove 2%; deň: day of storage

Plants and extraxts used in broiler nutrition

- Ban of the use of antibiotics as growth promoters in fattening animals (from 2006)
- One of the new alternatives are phytogenic feed additives - plants (herbs and spices) and their extracts and essential oils
- **Plant additives are often added to animal feed:**
  - **improve the taste and smell of the feed and thus improve the intake and growth of the animals**
  - **improve secretion of juices and enzyme activity in the intestine**
  - **increase the ability to absorb nutrients**
  - **significant antibacterial effect (suppression of pathogenic microflora in the gastro-intestinal tract)**
  - **reduction of mortality during fattening, especially during stress periods**
  - **antioxidant properties**

  Experiments
  - Extracts of oregano, rosemary, agrimony, sage
  - Herbs and spices: clove, Crataegus oxyacantha
- **Improvement of poultry production parameters and meat quality parameters**

Humic substances in broiler nutrition

- **Humic substances** - have a natural character are formed by the decomposition of organic matter.
- Humic and fulvic acids, a humins
- **Source - Leonardite - 100% natural substance with high biological efficiency**
- **technologically (mechanically, but not chemically) activated to a total humic acid content of more than 65 % -** natural humic substances, not salts of humic acids
- Applications in industry, agriculture, environment and biomedicine
- Detoxifying capacity
- Assist in the treatment of digestive disorders
- Improve immune system function
- Promote growth and carcass yield of poultry
- Positive effect on overall animal health
- Application in different concentrations (0.5 - 1.0%)

Humic substances and meat quality

Composition of meat produced after feeding of 0.8% (H0.8%) and 1.0% (H1.0%) humic substances in broiler chickens (35 days)

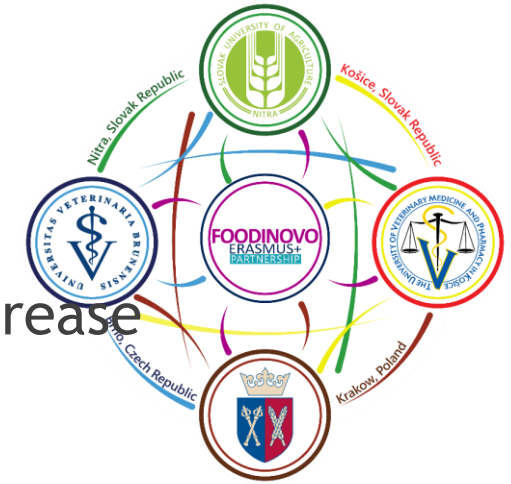
Breast	Control	H0.8%	H1.0%
Dry matter, %	24.78 ± 0.15	26.21 ± 0.47	25.68 ± 0.20
Total fat, %	3.40 ± 0.20	2.76 ± 0.10	2.86 ± 0.29
Total proteins, %	22.02 ± 0.40	23.71 ± 0.23	23.01 ± 0.23
Thigh	K	H0,8 %	H1,0%
Dry matter, %	29.48 ± 0.32	30.73 ± 0.31	29.50 ± 0.11
Total fat, %	11.29 ± 0.60	12.42 ± 0.33	11.04 ± 0.58
Total proteins, %	18.36 ± 0.32	19.34 ± 0.31	18.33 ± 0.23

Source: Semjon, Marcinčák et al. 2020. Multiple factorial analysis of physicochemical and organoleptic properties of breast and thigh meat of broilers fed a diet supplemented with humic substances. Poultry Science. 2020, 90, 1750 – 1760.

Humic substances in broiler nutrition

- Humic substances are a suitable alternative to the use of antibiotics as growth promoters
- Increased live weight of chicken and improved feed conversion
- Breast muscle fat content decreased and protein content increased
- Favourably influenced composition of fatty acids of fat of pector muscle
- Ratio of n-6/n-3 PUFAs decreased, the proportion of n-6 PUFAs (arachidonic acid) also decreased

Fermented feed



- **Preparation of feed used solid state fermentation (**SSF) to increase PUFAs in product
- Fermented feed - a biotechnological process based on the use of Solid-State Fermentation (SSF) and microscopic filamentous fungi (T*hamnidium*, *Cuninghamella*, *Mortierela* and *Umbelopsis*)
- **SSF** is a method in which microscopic filamentous fungi grow on moistened solid substrates (carbon source, carbohydrates) in the absence of free water to form PUFAs
- **Substrate:** by-products and wastes in the agro-food industry (scrap, bran, fruit peelings, apple pomace, pomace)

Fermented product and quality of meat

Breast	K	GLA (5%)	GLA+R
Dry matter (%)	25.09 ± 0.26	25.44 ± 0.42	24.60 ± 0.16
Total fat (%)	2.59 ± 0.16	2.35 ± 0.14	2.43 ± 0.19
Total proteins (%)	21.2 ± 0.2	21.5 ± 0.3	21.1 ± 0.2
Thigh	**K**	**GLA**	**GLA+R**
Dry matter (%)	28.85 ± 0.39	27.24 ± 0.25	26.13 ± 0.24
Total fat (%)	10.13 ± 0.41	7.80 ± 0.36	7.17 ± 0.41
Total proteins (%)	19.3 ± 0.7	20.1 ± 0.4	19.9 ± 0.4

Semjon, B., Marcinčák, S. et al. (2020). Effect of Solid-State Fermented Wheat Bran Supplemented with Agrimony Extract on Growth Performance, Fatty Acid Profile, and Meat Quality of Broiler Chickens. Animals, 10 (6), 942.

Fatty acid profile of produced fermented products

Fatty acid (%)	Fermented product (Fungus/substrate)			
	Thamnidium ellegans/ spelt bran	*Thamnidium ellegans*/ wheat bran	*Cuninghamella echinulata*/ wheat bran	*Umbelopsis isabellina*/ wheat bran
C 16:0, PA	13.91 ± 0.48	15.10 ± 0.56	16.59 ± 0.19	18.05 ± 0.03
C 18:0, SA	3.01 ± 0.41	2.76 ± 0.49	4.34 ± 0.60	3.23 ± 0.17
C 18:1 n-9, OA	25.48 ± 0.75	18.69 ± 1.84	22.72 ± 0.30	24.15 ± 0.44
C 18:1 n-7, VA	0.78 ± 0.09	0.59 ± 0.14	1.16 ± 0.04	0.85 ± 0.01
C 18:2 n-6, LA	**42.80 ± 1.34**	**43.04 ± 4.37**	**40.05 ± 1.92**	**45.54 ± 0.67**
C 18:3 n-6, GLA	**8.45 ± 0.91**	**15.30 ± 4.56**	**7.11 ± 0.80**	**2.05 ± 0.01**
C 18:3 n-3, ALA	**1.86 ± 0.32**	**2.30 ± 0.68**	**2.35 ± 0.21**	**3.05 ± 0.68**
C 20:1 n-9	0.89 ± 0.10	0.71 ± 0.15	0.90 ± 0.03	0.57 ± 0.02
C 22:0	0.31 ± 0.05	nd	0.66 ± 0.01	0.30 ± 0.04
C 24:0	0.79 ± 0.13	nd	1.31 ± 0.12	0.48 ± 0.02
∑ NMK	18.84 ± 0.61	18.28 ± 1.42	23.75	22.90 ± 0.20
∑ MNMK	28.05 ± 0.53	21.09 ± 2.00	25.33	26.45 ± 0.45
∑ PNMK	53.11 ± 1.18	60.63 ± 1.25	50.92	50.65 ± 0.65
Beta-carotene (ug/g)	nd	nd	nd	0.14 ± 0.02

PA-palmitic acid, SA-kys. Stearic acid,OA– oleic acid, VA –vaccenic acid, LA-linoleic acid, GLA– gama-linoleic acid, ALA–alpha-linoleic acid, NMK – saturated fatty acids, MNMK – monounsaturated fatty acids, PNMK – polyunsaturated fatty acids

Fermented products and fatty acids of chicken breast meat

Fatty acid (%)	Control	FK 10%	Control	FK 10 %
	raw	raw	thermal treated	thermal treated
C 16:0	21.62 ± 0.12	21.43 ± 0.39	20.38 ± 0.27	20.52 ± 0.17
C 18:0	9.42 ± 0.26	9.12 ± 0.67	7.20 ± 0.15	8.39 ± 1.03
C 18:1 n-9	30.31 ± 0.53	33.45 ± 0.59	39.10 ± 0.44	39.13 ± 0.94
C 18:1 n-7	3.89 ± 0.28	3.22 ± 0.13	2.96 ± 0.12	3.36 ± 0.18
C 18:2 n-6	16.34 ± 0.13	15.62 ± 0.27	16.30 ± 0.37	18.06 ± 0.10
C 18:3 n-6	0.119 ± 0.014	0.164 ± 0.038	0.117 ± 0.003	0.203 ± 0.038
C 18:3 n-3	0.819 ± 0.047	1.070 ± 0.023	1.11 ± 0.005	1.10 ± 0.12
C 20:0	0.074 ± 0.014	0.078 ± 0.016	-	-
C 20:1 n-9	0.459 ± 0.017	0.499 ± 0.039	0.446 ± 0.008	0.471 ± 0.013
C 20:3 n-6	1.20 ± 0.05	0.789 ± 0.047	0.402 ± 0.084	0.649 ± 0.024
C 20:3 n-3	0.081 ± 0.015	0.080 ± 0.020	0.037 ± 0.004	0.075 ± 0.010
C 20:4 n-6	5.75 ± 0.03	4.84 ± 0.25	1.98 ± 0.16	4.93 ± 0.24
C20:5 n-3	0.373 ± 0.047	0.264 ± 0.014	0.146 ± 0.043	0.160 ± 0.028
C22:5 n-3	0.193 ± 0.010	0.167 ± 0.025	0.105 ± 0.005	0.217 ± 0.002
C22:6 n-3	0.665 ± 0.024	0.268 ± 0.030	0.196 ± 0.009	0.261 ± 0.026
∑ SFA	34.42 ± 0.04	34.02 ± 0.07	31.23 ± 0.29	32.43 ± 0.77
∑UFA	65.72 ± 0.43	66.02 ± 0.18	68.73 ± 0.33	67.57 ± 0.67
∑ PUFA n-3	1.93 ± 0.07	1.97 ± 0.02	1.49 ± 0.01	1.60 ± 0.07
∑ PUFA n-6	23.89 ± 0.19	24.22 ± 0.02	19.03 ± 0.62	24.22 ± 0.017
n-6/n-3	12.41 ± 0.38	12.29 ± 0.17	12.77 ± 0.42	15.17 ± 0.54

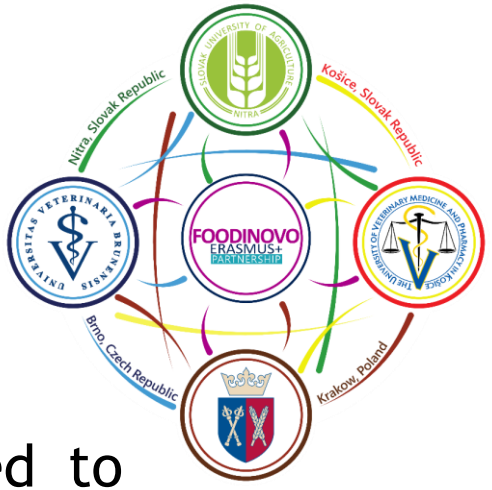
Source: MARCINČÁK et al. Effect of fungal solid-state fermented product in broiler chicken nutrition on quality and safety of produced breast meat. BioMed research international, 2018, 2018, art.no. 2609548.

SFA - saturated fatty acids; **UFA** - unsaturated fatty acids; **PUFA**- polyunsaturated fatty acids

Conclusion

- Presented natural feed additives have a significant impact on the fat composition and safety of produced meat
- **Vegetable oils -** reduce oxidative stability of meat, negative effect on production parameters of chickens
- **Plant extracts** – influenced fatty acid profile of fat, improved oxidative stability and have an effect on performance parameters of chicken (agrimony)
- **Humic substances** – beneficial effect on the fatty acid profile of meat fats, oxidative stability of meat preserved, improved production parameters of chicken
- **Fermented products** – beneficial effect on the fatty acid profile of meat fats, higher content of significant PUFAs, improved oxidative stability of meat, preserved production parameters of chickens

Conclusion



- In the last decade, the view of food has been changing dramatically.
- Food is not only seen as a source of energy, but we are expected to prevent disease and improve the physical and mental health of the consumer - functional foods
- The intention of further research is to search for a combination of suitable additives to improve the MK profile, increase oxidative stability, improve production parameters of broiler chickens and the production of a functional food – meat
- Fermented products and humic substances represent a suitable combination of feed additves to address the above objective

Thank you for your attention

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