Co-funded by
the European Union

Open Food Innovation University (OFINU)

DESCRIPTION OF STUDY MODULE

“FRUIT AND VEGETABLE PROCESSING TECHNOLOGIES”

2024

Summary

The study course is elaborated within the project “Open Food Innovation University" (OFINU), being in implementation with support of the European Union Erasmus+ Programme.

Overall objective of the project - to modernise food innovation and technology related higher education in Uzbekistan and Tajikistan, thereby increasing the quality and ensuring relevance of the higher education to the needs of the socio-economic growth of the countries concerned and especially of their regions.

Full partners:

- Lead partner: Latvia University of Life Sciences and Technologies
- Uzbekistan: Samarkand Agro-innovations and Research University, Andijan Institute of Agriculture and Agro-technologies
- Tajikistan: Technological University of Tajikistan, Kulob Institute of Technology and Innovation Management, Isfara Branch of the Technological University of Tajikistan
- Slovakia: Slovak University of Agriculture in Nitra

Associated partners in Uzbekistan:

- A group of companies "AGROMIR"
- "Navigul" MCHJ QK
- “Samarqand don mahsulotlari” JC (Samarkand grain products)

Associated partners in Tajikistan:

- CJSC “Combinati Shiri Dushanbe”
- LTD "Orion Rustam"
- Association of Entrepreneurs of Khatlon

The project implementation period: 01/02/2024 - 31/01/2027.

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

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INTRODUCTION

The study module “Fruit and vegetable processing technologies” has been developed for students to get them acquainted with basic knowledge on fruit and vegetable processing technologies as well as new product development.

The aim and objectives of the study subject are to provide knowledge about technological processes of fruit and vegetable processing, the equipment used and packaging options, and product quality requirements. Students obtain knowledge about the chemical composition and physical properties of fruits and vegetables. They acquire basic knowledge about fruit and vegetable processing and physical, biochemical and microbiological processes during the production of these products. They also get informed about defects of fruit and vegetable products and possible options to avoid them. They obtain the sensory evaluation principles of fruit and vegetable processing products. Get acquainted with special equipment used in this industry, product packaging solutions, and product risk and safety assessment.

Learning outcomes:

- ***Knowledge*** – about processing principles of different fruit and vegetable products, including physical, biochemical and microbiological processes during the production of these products; the innovation possibilities and development of new products.
- ***Skills*** – to evaluate the quality parameters of fruits and vegetables and their processing products, to lead and control the technological processes of different fruit and vegetable processing products; independently organise a new product development process.
- ***Competences*** – to analyse and explain the physical, biochemical and microbiological processes during the production of different fruit and vegetable products.

Study Plan for module “Fruit and Vegetable Processing Technologies”

Themes		Number of hours				Number of hours UZB		
		Total	Lectures	Practical works	Independent work	Total	Lectures	Practical works
1	Chemical composition and physical properties of fruits, vegetables, and mushrooms. Fruit and vegetable classification.	35	9	8	18	12	4	8
2	Classification of fruit and vegetable processing products.	10	3		7	10	2	8
3	Fresh, minimally processed fruits and vegetables.	30	1	14	15	2	2	-

4	Packaging equipment and special packaging materials and methods used in fruit and vegetable product production	20	4	*	16	2	2	-
5	Technological equipment for fruit and vegetable processing	19	4	*	15	10	2	8
6	Fermented fruit and vegetable production.	20	1	8	11	10	2	8
7	Assessment of the Safety and Risks of Fruit, Vegetable Products (HACCP).	25	2	4	19	2	2	-
8	Microbiological aspects of fruit and vegetable processing	12	2	*	10	10	2	8
9	Production technology of frozen fruits and vegetables.	20	2	4	14	10	2	8
10	Sensory aspects of fruit and vegetable processing products	19	2	*	17	10	2	8
11	Thermally processed vegetable preserves.	40	8	16	16	10	2	8
12	Thermally processed fruit and berry preserves.	39	6	14	19	10	2	8
13	Vegetable oils	15	3	2	10	10	2	8
14	Dried fruit and vegetable products.	20	1	7	12	8	2	6
TOTAL		**324**	**48**	**77**	**199**	**116**	**30**	**86**

*The practical part is included in other topics, see Thematic Study plan

Thematic Study Plan for module
"Fruit and Vegetable Processing Technologies"

Date, Time	Study form	Theme	Lecturer
Theme 1. Chemical composition and physical properties of fruit, vegetables, and mushrooms. Fruit and vegetable classification			
Day 1	Lecture (2h)	*Introduction lecture about the study course.* Chemical composition and physical properties of fruit and vegetables.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (3h)	Chemical composition of fruit, berries and vegetables.	
	Lecture (1h)	Fruit and vegetable classification.	
	Lecture (1h)	Mushrooms - structure and chemical composition.	
Day 2	Lecture (4h)	Chemical composition and quality aspects of herbs, wild and domesticated fruit and berries. Nuts, their chemical composition and quality characteristics. Citrus fruits, their chemical composition.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (3h)	Natural pigments and their detection, quality changes in fruit, berries and vegetables.	
Day 3	Lecture (1h)	Structure and chemical composition of potato tubers.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Chemical composition and quality parameters of potato tubers.	
Theme 2. Classification of fruit and vegetable processing products			
Day 3	Lecture (1h)	Introduction to the fruit, berry and vegetable processing industry in "Your Country".	Dr.sc.ing. Assist.prof L. Ozola
	Lecture (2h)	Fruit and vegetable storage conditions. Methods of preserving fruits, berries and vegetables.	Dr.sc.ing. Assist.prof L. Ozola
Theme 3. Fresh, minimally processed fruit and vegetables			
Day 4	Lecture (1h)	Production of fresh, minimally processed fruits and vegetables.	Dr.sc.ing. Assist.prof L. Ozola

Theme 4. Packaging equipment and special packaging materials and methods used in fruit and vegetable product production			
Day 4	Lecture (4h)	Packaging equipment and special packaging materials and methods used in fruit and vegetable product production.	Dr. sc. ing. professor S. Muizniece - Brasava
	Laboratory work (3h)	*Connected and a continuation of Theme 3* Preparation of fresh, cut and packaged vegetables (1st part).	Dr.sc.ing. Assist.prof L. Ozola / Dr. sc. ing. professor S. Muizniece - Brasava
Theme 5. Technological equipment for fruit and vegetable processing			
Day 5	Lecture (4h)	Overview of technological equipment for fruit and vegetable processing.	Dr. sc. ing. professor T. Ķince
Theme 6. Fermented fruit and vegetable production			
Day 5	Lecture (1h)	Fermented vegetables - technological aspects of preparation and product quality with focus on sauerkraut production).	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Preparation of sauerkraut (1st part).	
Theme 7. Assessment of the Safety and Risks of fruit and vegetable products (HACCP)			
Day 8	Lecture (2h)	Assessment of Safety and Risks of fruit and vegetable products (HACCP).	Mg.tqf. lecturer E. Sproģe
	Practical work / Seminar (4h)	Assessment of Safety and Risks of fruit and vegetable products (HACCP).	Mg.tqf. lecturer E. Sproģe
Day 9	Excursion	Excursion to a local fruit and vegetable processing company.	Dr.sc.ing. Assist.prof L. Ozola
Theme 8. Microbiological aspects of fruit and vegetable processing			
Day 10	Lecture (2h)	Microbiological aspect in fruit and vegetable processing.	Dr.sc.ing. Assist.prof L. Ozola
Continuation of laboratory work from Day 4 and in the context of Themes 3, 4 and 8			

Day 10	Laboratory work (2h)	Microbiological evaluation of fresh, cut and packaged vegetables (2nd part).	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (4h)	Quality evaluation of fresh, cut and packaged vegetables (3rd part).	
Theme 9. Production technology of frozen fruits and vegetables			
Day 11	Lecture (2h)	Production of frozen fruit and vegetables	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (1h)	Freezing of fruit and vegetables (1st part)	
Theme 10. Sensory aspects of fruit and vegetable processing products			
Day 11	Lecture (2h)	Fruit, berry and vegetable and their product sensory evaluation.	Dr. sc. ing. professor E. Straumite
Continuation of Themes 6			
Day 12	Laboratory works (2h)	Microbiological evaluation of prepared sauerkraut (2nd part).	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Packaging and storage of sauerkraut. Product treatment in sous-vide. (3rd part)	Dr. sc. ing. professor S. Muizniece - Brasava
Continuation of Day 10 and conclusion of Theme 3			
Day 15	Laboratory work (1h)	Data collection of microbiological assessment of fresh, cut and packaged vegetables.	Dr.sc.ing. Assist.prof L. Ozola
	Seminar (1h)	*Conclusion of Theme 3.* Seminar on obtained data and evaluation of laboratory works.	
Continuation of Day 12 and conclusion of Theme 6			
Day 15	Laboratory work (1h)	Data collection of microbiological assessment of prepared sauerkraut.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Sensory evaluation of sauerkraut.	Dr. sc. ing. professor E. Straumite
	Laboratory work (2h)	Quality evaluation of prepared sauerkraut.	Dr.sc.ing. Assist.prof

	Seminar (1h)	*Conclusion of Theme 6.* Seminar on obtained data and evaluation of laboratory works.	L. Ozola
Theme 11. Thermally processed vegetable preserves			
Day 16	Lecture (2h)	Natural preserves. Testing of canned food sterility.	Dr.sc.ing. Assist.prof L. Ozola
	Lecture (4h)	Processing of tomatoes. Production of acidified vegetable preserves.	
Day 17	Laboratory work (6h)	Preparation of tomato concentrates and sauces using different technologies.	Dr.sc.ing. Assist.prof L. Ozola / Dr. sc. ing. professor T. Ķince
Day 18	Laboratory work (2h)	Quality assessment of prepared tomato products.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Sensory evaluation of prepared tomato products.	Dr. sc. ing. professor E. Straumite
	Lecture (2h)	Potato processing products and technologies, needed equipment, and their characteristics.	Dr.sc.ing. Assist.prof L. Ozola
Day 19	Laboratory work (4h)	Preparation and analysis of potato processing using different technologies - French fries.	Dr.sc.ing. Assist.prof L. Ozola / Dr. sc. ing. professor T. Ķince
	Laboratory work (2h)	Preparation and analysis of potato processing using different technologies – chips -Preparation stage.	Dr.sc.ing. Assist.prof L. Ozola
Day 22	Laboratory work (2h)	Preparation and analysis of potato processing using different technologies - chips- Analysis stage.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (1h)	Sensory evaluation of potato chips.	Dr. sc. ing. professor E. Straumite
	Seminar (1h)	*Conclusion of Theme 11.* Seminar on obtained data and evaluation of laboratory works.	Dr.sc.ing. Assist.prof L. Ozola
Continuation of Day 12 and conclusion of Theme 9			

Day 22	Laboratory work (3h)	Quality analysis of frozen fruit, berries and vegetables (2nd part). *Conclusion of Theme 9.* Seminar on obtained data and evaluation of laboratory works.	Dr.sc.ing. Assist.prof L. Ozola
Theme 12. Thermally processed fruit and berry preserves			
Day 23	Lecture (2h)	Classification of fruit and berry processing products. The technology and equipment of preparation of compotes and jams, purees.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (2h)	Apple compote preparation (1st part).	Dr.sc.ing. Assist.prof L. Ozola / Dr. sc. ing. professor S. Muizniece - Brasava
	Lecture (2h)	The technology of fruit and berry marmalade production.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (1h)	Preparation of fruit and berry marmalades using different gelling agents.	Dr.sc.ing. Assist.prof L. Ozola
Day 24	Laboratory work (2h)	Quality evaluation of apple compotes.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (1h)	Sensory analysis of fruit and berry marmalades.	Dr. sc. ing. professor E. Straumite
	Laboratory work (2h)	Quality analysis of fruit and berry marmalades	Dr.sc.ing. Assist.prof L. Ozola
	Lecture (2h)	Fruit, berry and vegetable juices, their division and juice production technologies, and equipment.	
Day 25	Laboratory work (5h)	Fruit, berry and vegetable juice production (preparation of samples) and quality evaluation.	Dr.sc.ing. Assist.prof L. Ozola
	Seminar (1h)	*Conclusion of Theme 12.* Seminar on obtained data and evaluation of laboratory work.	
Theme 13. Vegetable oils			
Day 26	Lecture (3h)	Oils, their division and extraction methods.	Dr.sc.ing. Assist.prof

			L. Ozola / Dr. sc. ing. professor T. Ķince
	Laboratory work (2h)	Quality analysis of vegetable oils. *Conclusion of Theme 13.* Seminar on obtained data and evaluation of laboratory work.	Dr.sc.ing. Assist.prof L. Ozola
Theme 14. Dried fruit and vegetable products			
Day 29	Lecture (1h)	Drying of fruits, berries and vegetables.	Dr.sc.ing. Assist.prof L. Ozola
	Laboratory work (5h)	Apple drying using different technologies.	Dr.sc.ing. Assist.prof L. Ozola / Dr. sc. ing. professor T. Ķince
Day 30	Laboratory work (2h)	Quality evaluation of dried apples. *Conclusion of Theme 13.* Seminar on obtained data and evaluation of laboratory works.	Dr.sc.ing. Assist.prof L. Ozola
	Excursion	Excursion to a local fruit and vegetable processing company.	

Themes and their summary in study module "Fruit and Vegetable Processing Technologies"

Theme 1. Chemical composition and physical properties of fruits, vegetables, and mushrooms. Fruit and vegetable classification

Issues to be covered in the lectures

1. Overall chemical composition and properties of fruits and vegetables;
2. Classification of fruits and vegetables;
3. Chemical composition and description of various wild fruits and berries;
4. Chemical composition and description of various herbs;
5. Classification, chemical composition and description of nuts;
6. Chemical composition and description of citrus fruit;
7. Structure and chemical composition and quality parameters of potato tubers;
8. Classification, description and chemical composition of mushrooms.

Issues to be covered in the practical or laboratory works

1. Chemical composition of fruits, berries and vegetables.
2. Natural pigments and their detection, quality changes in fruits, berries and vegetables;
3. Chemical composition and quality parameters of potato tubers.

Topics of independent work

1. Comparative analysis of phytochemical profiles and antioxidant activity in organic vs conventionally grown produce.
2. Impact of post-harvest processing on nutrient retention and textural properties of fruits/ vegetables/ mushrooms.
3. Exploring the role of mushrooms as functional foods: bioactive compounds and health benefits

Literature and data bases on the theme

1. Hui, Y. H. (Ed.). (2010). Handbook of fruit and vegetable flavors. Wiley.
2. Yahia, E. M. (Ed.). (2019). Postharvest physiology and biochemistry of fruits and vegetables. Woodhead Publishing.
3. Mérillon, J.-M., & Ramawat, K. G. (Eds.). (2018). Bioactive molecules in food. Springer.
4. Lim, T. K. (2012). Edible medicinal and non-medicinal plants: Volume 1, fruits. Springer.
5. Jaiswal, A. K. (Ed.). (2020). Nutritional composition and antioxidant properties of fruits and vegetables. Academic Press.

Theme 2. Classification of fruit and vegetable processing products

Issues to be covered in the lectures

1. Introduction to the fruit, berry and vegetable processing industry in 'Your Country'.
2. Fruit and vegetable storage conditions.
3. Methods of preserving fruits, berries and vegetables

Issues to be covered in the practical or laboratory works

The topics discussed in this theme of the study course 'Fruit and vegetable processing technologies', from a practical point of view is discussed in combination and according to other themes directly connected with fruit and vegetable processing product production.

Topics of independent work

1. Emerging technologies in fruit and vegetable processing: Classification and impact on product quality.
2. Classification and nutritional evaluation on plant-based food alternatives from fruits and vegetables.
3. Volarization of fruit and vegetable by-products: classification, processing and application.

Literature and data bases on the theme

1. Fellows, P. J. (2017). Food processing technology: Principles and practice (4th ed.). Woodhead Publishing.
2. Jongen, W. (Ed.). (2002). Fruit and vegetable processing: Improving quality. Woodhead Publishing.
3. Sinha, N. K., Hui, Y. H., Evranuz, E. Ö., Cano, M. P., Barta, J., & Siddiqi, J. I. (Eds.). (2012). Handbook of fruits and fruit processing. Wiley-Blackwell.

Theme 3. Fresh, minimally processed fruits and vegetables

Issues to be covered in the lectures

1. Fresh and minimally processed fruit and vegetable production. Physico-chemical changes, enzymatic, microbiological and other external factor impact on product quality.
2. Fresh and minimally processed fruit and vegetable packaging and storage conditions to ensure product quality.

Issues to be covered in the practical or laboratory works

1. Fresh, cut and packaged vegetable preparation
2. Quality evaluation of fresh, cut and packaged vegetables
3. Microbiological assessment of fresh, cut and packaged vegetables

Topics of independent work

1. Exploring the impact of edible coating on the shelf life and quality of fresh fruits and vegetables
2. Innovative packaging solutions for minimally processed fruits and vegetables: sustainability perspective

Literature and data bases on the theme

1. Ahvenainen, R. (Ed.). (2003). Novel food packaging techniques. Woodhead Publishing.
2. Bahrami, A., Moosavi-Nasab, M., Ghanbarzadeh, B., & Khodaiyan, F. (2020). Application of edible films and coatings in fresh fruits and vegetables. Food Science & Nutrition, 8(12), 5240–5254. https://doi.org/10.1002/fsn3.1877
3. Barrett, D. M., Somogyi, L. P., & Ramaswamy, H. S. (Eds.). (2004). Processing fruits: Science and technology (2nd ed.). CRC Press.
4. Martin-Belloso, O., & Soliva-Fortuny, R. (Eds.). (2010). Advances in fresh-cut fruits and vegetables processing. CRC Press.

Theme 4. Packaging equipment and special packaging materials and methods used in fruit and vegetable product production

Issues to be covered in the lectures

1. Characteristics of packaging materials suitable for fruits, vegetables and berries (fresh and processed).
2. Packaging Equipment that allows fruit/vegetables to be packaged in different packaging technologies (in AIR, Vacuum packaging, EMAP packaging).
3. Control of gases inside the package above the products.

Issues to be covered in the practical or laboratory works

The topics discussed in this theme of the study course 'Fruit and vegetable processing technologies', from a practical point of view is discussed in combination and according to other themes directly connected with fruit and vegetable processing product production.

1. How do packaging materials affect the delivery time of fruits, vegetables and berries?
2. How packaging technologies affect the delivery time of fruits, vegetables and berries?
3. Packaging as an element of added value.

Topics of independent work

1. 1.Describing fruit and vegetable packages and packaging technologies.
2. 2.Analyze scientific literature on fruit, berry and vegetable packaging solutions.
3. 3. Optimization of packaging towards sustainability.

Literature and data bases on the theme

1. Mavinkere, S., Rangappa, P. J., Senthil M. K., Thiagamani, S. K., Suchart, S. (2020) Food Packaging: Advanced Materials, Technologies, and Innovations (1st ed.). CRC Press.
2. Chonhenchob, V., Singh, P., Singh, J. (2016) Packaging & Distribution of Fresh Fruits & Vegetables. Destech Pubns Inc.
3. Tanweer, A. (Ed.). (2022). Packaging and Storage of Fruits and Vegetables Emerging Trends (1st ed.). Apple Academic Press.

Theme 5. Technological equipment for fruit and vegetable processing

Issues to be covered in the lectures

1. Washing and sorting: washing machine, water transport, inspection equipment, calibration equipment, optical sorter.
2. Peeling, chopping: vegetable peeling machine, apple peeling and cutting machine, cherry pitting machine, vegetable chopping machine, berry crushing machine, masher.
3. Mixers, homogenizers.
4. Juicers.
5. Filters, membrane technologies.
6. Juice concentration: vacuum vaporizer, membrane filters.
7. Thermal treatment: blanching machine, vacuum cooking pots, frying equipment, pasteurizers, sterilisers (autoclaves).
8. Drying: convective, freeze driers, infrared, vacuum.
9. Cooling equipment.
10. Freezing equipment.

Issues to be covered in the practical or laboratory works

The topics discussed in this theme of the study course 'Fruit and vegetable processing technologies', from a practical point of view is discussed in combination and according to other themes directly connected with fruit and vegetable processing product production.

Topics of independent work

1. Advancements in non-thermal processing technologies: evaluating the impact on nutritional and sensory quality of fruits and vegetables
2. energy-efficient technologies i fruit and vegetable drying: innovations and sustainability

Literature and data bases on the theme

1. Barrett, D. M., Somogyi, L. P., & Ramaswamy, H. S. (Eds.). (2004). Processing fruits: Science and technology (2nd ed.). CRC Press. ISBN: 978-1-56676-931-3
2. Brennan, J. G. (Ed.). (2006). Food processing handbook. Wiley-VCH. ISBN: 978-3-527-31379-3
3. Fellows, P. J. (2017). Food processing technology: Principles and practice (4th ed.). Woodhead Publishing. ISBN: 978-0-08-101907-8
4. Lozano, J. E. (Ed.). (2006). Fruit manufacturing: Scientific basis, engineering properties, and deterioration behavior. Springer. ISBN: 978-0-387-26014-8
5. Saravacos, G. D., & Kostaropoulos, A. E. (2016). Handbook of food processing equipment (2nd ed.). Springer. ISBN: 978-1-4939-3115-3

Theme 6. Fermented fruit and vegetable production

Issues to be covered in the lectures

1. Types of fermented plant-based products.
2. Production technology of sauerkraut. Key elements of successful fermentation.
3. Differences between untreated sauerkraut and pasteurised, including nutritional benefits.

Issues to be covered in the practical or laboratory works

1. Preparation of sauerkraut.
2. Packaging and storage of sauerkraut. Product treatment in sous-vide.
3. Microbiological evaluation of prepared sauerkraut.
4. Sensory evaluation of sauerkraut.
5. Quality evaluation of prepared sauerkraut.

Topics of independent work

1. Microbial diversity and functional properties of fermented fruit and vegetable products
2. Innovative fermentation techniques for enhanced flavour and nutritional value
3. Utilization of by-products from fermented fruit and vegetable production: value addition and sustainability

Literature and data bases on the theme

1. Marco, M. L., Heeney, D., Binda, S., Cifelli, C. J., Cotter, P. D., Foligné, B., Gänzle, M., Kort, R., Pasin, G., Pihlanto, A., Smid, E. J., Hutkins, R., & Ventura, M. (2017). Health benefits of fermented foods: Microbiota and beyond. Current Opinion in Biotechnology, 44, 94-102. doi:10.1016/j.copbio.2016.11.010
2. Speranza, B., Bevilacqua, A., Corbo, M. R., Sinigaglia, M., & Campaniello, D. (2018). Microbial dynamics during fermentation of an Italian fermented vegetable product as revealed by metagenomic analysis. LWT - Food Science and Technology, 92, 541-547. doi:10.1016/j.lwt.2018.03.019
3. Tamang, J. P., & Kailasapathy, K. (Eds.). (2010). Fermented foods and beverages of the world. CRC Press.
4. Tamang, J. P., Shin, D. H., Jung, S. J., & Chae, S. W. (2016). Functional properties of microorganisms in fermented foods. Frontiers in Microbiology, 7, 578. doi:10.3389/fmicb.2016.00578

Theme 7. Assessment of the Safety and Risks of fruit, vegetable products (HACCP)

Issues to be covered in the lectures

1. What is Food Safety?
2. How many and Which principles are used to build HACCP system?
3. Please describe prerequisite programs and their role in HACCP system?

Issues to be covered in the practical or laboratory works

1. How is Matrix that we use for risk assessment build?
2. What is the difference between Matrix and decision tree?
3. For what/why do we use records of CCP monitoring?

Topics of independent work

1. How to identify - whether the supplier is low, medium or high risk?
2. Description of known so far counterfeiting of fruit and vegetables.

Literature and databases on the theme

1. Wallace, C. A., Sperber, W. H., & Mortimore, S. E. (2018). Food safety for the 21st century: Managing HACCP and food safety throughout the global supply chain (2nd ed.). Wiley.
2. Codex Alimentarius. (n.d.). Retrieved from http://www.fao.org/fao-who-codexalimentarius/en/
3. European Commission. (2022). EU COMMISSION NOTICE on the implementation of food safety management systems covering Good Hygiene Practices and procedures based on the HACCP principles. Official Journal of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022XC0916%2801%29
4. BRCGS. (n.d.). Global standard for food safety issue 9. Retrieved from https://www.brcgs.com/our-standards/food-safety/issue-9-revision/

Theme 8. Microbiological aspects of fruit and vegetable processing

Issues to be covered in the lectures

1. Classification of microorganisms (overview).
2. Most commonly found microorganisms and causes for microbiological spoilage of fruits, vegetables and their processing products.
3. Causes of microbiological spoilage defects in canned goods.
4. Pathogens found in canned fruit and vegetable products.
5. Local and European legislative regulations regarding microbiological contamination of fruits, vegetables and their processing products.

Issues to be covered in the practical or laboratory works

The topics discussed in this theme of the study course 'Fruit and vegetable processing technologies', from a practical point of view is discussed in combination and according to other themes directly connected with fruit and vegetable processing product production.

Topics of independent work

1. Microbial biofilms in fruit and vegetable processing: formation, control and implications for food safety.
2. Bio preservation strategies for extending shelf life and enhancing safety of fresh-cut fruits and vegetables.

Literature and data bases on the theme

1. Food Science Source. (n.d.). Retrieved from https://www.ebsco.com/products/research-databases/food-science-source
2. PubMed. (n.d.). Retrieved from https://pubmed.ncbi.nlm.nih.gov/
3. European Parliament and Council. (2023). Regulation (EU) 2023/988 on general product safety. Official Journal of the European Union.
4. European Parliament and Council. (2011). Regulation (EU) No 1169/2011 on the provision of food information to consumers. Official Journal of the European Union.
5. Samelis, J. (Ed.). (2014). *Foodborne pathogens: Hazards, risk analysis and control* (2nd ed.). Woodhead Publishing.

Theme 9. Production technology of frozen fruits and vegetables

Issues to be covered in the lectures

1. Production technology of frozen fruits and vegetables.
2. Types of freezing mechanisms.
3. Quality parameters of fruits and vegetables suitable for freezing.
4. Fruit and vegetable pre-treatment methods before freezing.

Issues to be covered in the practical or laboratory works

1. Freezing of fruits and vegetables.
2. Quality analysis of frozen fruits and vegetables.

Topics of independent work

1. Energy-efficient freezing techniques.
2. Sustainable packaging solutions for frozen produce.
3. Blockchain technology for traceability and quality assurance.

Literature and data bases on the theme

1. Fellows, P. (2009). Food processing technology: Principles and practice (3rd ed.). Woodhead Publishing.
2. Sun, D.-W. (Ed.). (2005). Emerging technologies for food processing. Elsevier Academic Press.
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Theme 10. Sensory aspects of fruit and vegetable processing products

Issues to be covered in the lectures

1. Changes in sensory properties of fruit and vegetables in technological processes
2. Characteristics of sensory properties - appearance, colour, aroma, texture, taste and aftertaste.
3. Sensory methods used in the evaluation of processed fruits and vegetables.

Issues to be covered in the laboratory works

The topics discussed in this theme of the study course 'Fruit and vegetable processing technologies', from a practical point of view is discussed in combination and according to other themes directly connected with fruit and vegetable processing product production.

1. What sensory properties should be evaluated for fruits and vegetables and their processing products?
2. What sensory methods can be used to evaluate fruits and vegetables and their processed products?
3. How to present and analyse the results obtained in sensory evaluation?

Topics of independent work

1. Analysis of obtained results.
2. To find a more theoretical background of sensory quality parameters of fruits and vegetables.

Literature and data bases on the theme

1. OECD. (n.d.). International standards for fruit and vegetables. Retrieved from https://www.oecd-ilibrary.org/agriculture-and-food/international-standards-for-fruit-and-vegetables_19935668?page=1
2. Fruitrop. (n.d.). Quality defects. Retrieved from https://www.fruitrop.com/en/Articles-by-subject/Quality-defects

Theme 11. Thermally processed vegetable preserves

Issues to be covered in the lectures

1. Natural preserves.
2. Testing of canned food quality.
3. Processing of tomatoes.
4. Production of acidified vegetable preserves.
5. Potato processing products and technologies, needed equipment, and their characteristics.

Issues to be covered in the practical or laboratory works

1. Preparation and analysis of potato processing products using different technologies - French fries.
2. Preparation and analysis of potato processing products using different technologies – chips.
3. Sensory evaluation of potato chips.
4. Preparation of tomato concentrates and sauces using different technologies.
5. Quality assessment of prepared tomato products.
6. Sensory evaluation of prepared tomato products.

Topics of independent work

1. Impact on thermal processing on nutritional quality and safety of products.
2. Consumer acceptance and market trend of thermally processed vegetable preserves.
3. Sustainability and environmental impact of thermally processed vegetable preserves.
4. Study of the influence of various methods of heat treatment on the preservation of nutrients in canned vegetables.
5. Comparison of preservation methods: heat treatment, sterilization, pasteurization.
6. Assessment of changes in the content of vitamins, minerals and antioxidants after various types of heat treatment.

Literature and data bases on the theme

1. Barbosa-Cánovas, G. V., & Gould, G. W. (Eds.). (2000). Innovative food processing technologies. CRC Press.
2. Gould, G. W. (Ed.). (2012). New methods of food preservation. Springer Science & Business Media.
3. Ramaswamy, H. S., & Marcotte, M. (2006). Food processing: Principles and applications. CRC Press.
4. Расулов, А. (1995). Сабзавот, картошка ва полиз ма\сулотларини саклаш. Мехнат.
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Theme 12. Thermally processed fruit and berry preserves

Issues to be covered in the lectures

1. Classification of fruit and berry processing products.
2. The technology and equipment of preparation of compotes and jams, purees.
3. The technology of fruit and berry marmalade production.
4. Gelling agents used in fruit and berry product production.
5. Fruit, berry and vegetable juices, their division and juice production technologies and equipment.

Issues to be covered in the practical or laboratory works

1. Apple compote preparation.
2. Quality evaluation of apple compotes.
3. Preparation of fruit and berry marmalades using different gelling agents.
4. Quality analysis of fruit and berry marmalades.
5. Sensory analysis of fruit and berry marmalades.
6. Principles of production of fruit and vegetable juices, evaluation of prepared juices.

Topics of independent work

1. Impact of thermal processing on nutritional quality and bioactive compounds.
2. Consumer preferences and market trends for thermally processed fruit and berry preserves.
3. Study of the main stages of production, including preparation of raw materials, heat treatment, packaging and preservation.
4. Analysis of the content of vitamins, minerals, antioxidants and other nutrients in canned fruits and berries.
5. Research on methods for controlling the microbiological composition of canned food, preventing the growth of bacteria, mold and yeast.

Literature and data bases on the theme

1. Ashurst, P. R. (Ed.). (2016). Chemistry and technology of soft drinks and fruit juices (3rd ed.). Wiley-Blackwell.
2. Silva, C. L. M., & Oliveira, F. A. R. (Eds.). (2008). Thermal food processing: New technologies and quality issues. CRC Press.
3. Tressler, D. K., Joslyn, M. A., & Marsh, G. L. (1968). The chemistry and technology of fruit and vegetable juice production. AVI Publishing Company.
4. Расулов, А. (1995). Сабзавот, картошка ва полиз ма\сулотларини саклаш. Мехнат.
5. Орипов, Р. О., & бошкалар. (1991). Кишлок хужалиги махсулотларини саклаш ва кайта ишлаш технологияси. Мехнат.
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Theme 13. Vegetable oils

Issues to be covered in the lectures

1. Vegetable oil division and extraction methods.
2. Essential quality parameters of oils.
3. Production of vegetable oils.

Issues to be covered in the practical or laboratory works

1. Vegetable oil analysis.

Topics of independent work

1. Chemical and nutritional analysis of different vegetable oils.
2. Sustainability and environmental impact of vegetable oil production.
3. Market trends and consumer preferences in the vegetable oil industry.
4. Comparative analysis of the physical, chemical and nutritional properties of various types of vegetable oils.
5. Study of technologies for the production of vegetable oils, including extraction and purification methods.
6. Analysis of the environmental impact of vegetable oil production, including issues of sustainable agriculture and potential negative impacts on ecosystems.

Literature and data bases on the theme

1. Gunstone, F. D. (Ed.). (2011). Vegetable oils in food technology: Composition, properties, and uses (2nd ed.). Wiley-Blackwell.
2. Hamm, W., Hamilton, R. J., & Calliauw, G. (Eds.). (2013). Edible oil processing (2nd ed.). Wiley-Blackwell.
3. Shahidi, F. (Ed.). (2005). Bailey's industrial oil and fat products (6th ed., Vols. 1-6). Wiley-Interscience.
4. Расулов, А. (1995). Сабзавот, картошка ва полиз ма\сулотларини саклаш. Мехнат.
5. Орипов, Р. О., & бошкалар. (1991). Кишлок хужалиги махсулотларини саклаш ва кайта ишлаш технологияси. Мехнат.
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Theme 14. Dried fruit and vegetable products

Issues to be covered in the lectures

1. Drying methods of fruits, berries and vegetables.
2. Key elements to dried product quality, specific to the dehydration method.

Issues to be covered in the practical or laboratory works

1. Apple drying using different technologies.
2. Quality evaluation of dried apples.

Topics of independent work

1. Nutritional and chemical changes during drying consumer preferences and market trends in dried fruit and vegetable products.
2. Sustainability and environmental impact of dried fruit and vegetable product production.
3. Methods of production of dried fruits and vegetable products.
4. Nutritional value of dried fruits and vegetable products.
5. Research of modern drying and packaging technologies aimed at preserving the taste and nutritional value of products.

Literature and data bases on the theme

1. Baird-Parker, T. C., Gould, G. W., & Lund, B. M. (Eds.). (2000). *Microbiological safety and quality of food* (Vol. 1). Springer.
2. Mujumdar, A. S. (Ed.). (2014). *Handbook of industrial drying* (4th ed.). CRC Press
3. Sinha, N. K., Sidhu, J. S., Barta, J., Wu, J. S. B., & Cano, M. P. (Eds.). (2012). *Handbook of fruits and fruit processing* (2nd ed.). Wiley-Blackwell.
4. Расулов, А. (1995). Сабзавот, картошка ва полиз ма\сулотларини саклаш. Мехнат.
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7. Буриев, Х., & Ризаев, Р. (1996). Мева, узум махсулотлари биокимёси ва технологияси. Мехнат.

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1. Ahvenainen, R. (Ed.). (2003). *Novel food packaging techniques*. Woodhead Publishing.
2. Ashurst, P. R. (Ed.). (2016). *Chemistry and technology of soft drinks and fruit juices* (3rd ed.). Wiley-Blackwell.
3. Bahrami, A., Moosavi-Nasab, M., Ghanbarzadeh, B., & Khodaiyan, F. (2020). Application of edible films and coatings in fresh fruits and vegetables. *Food Science & Nutrition, 8*(12), 5240–5254. https://doi.org/10.1002/fsn3.1877
4. Baird-Parker, T. C., Gould, G. W., & Lund, B. M. (Eds.). (2000). *Microbiological safety and quality of food* (Vol. 1). Springer.
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6. Barrett, D. M., Somogyi, L. P., & Ramaswamy, H. S. (Eds.). (2004). *Processing fruits: Science and technology* (2nd ed.). CRC Press.
7. Brennan, J. G. (Ed.). (2006). *Food processing handbook*. Wiley-VCH.
8. Wallace, C. A., Sperber, W. H., & Mortimore, S. E. (2018). *Food safety for the 21st century: Managing HACCP and food safety throughout the global supply chain* (2nd ed.). Wiley.
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10. European Commission. (2022). EU COMMISSION NOTICE on the implementation of food safety management systems covering Good Hygiene Practices and procedures based on the HACCP principles. Official Journal of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022XC0916%2801%29
11. Fellows, P. (2009). *Food processing technology: Principles and practice* (3rd ed.). Woodhead Publishing.
12. Fellows, P. J. (2017). *Food processing technology: Principles and practice* (4th ed.). Woodhead Publishing.
13. Rangappa, S. M., Jyotishkumar, P., Thiagamani, S. M. K., Krishnasamy, S., & Siengchin, S. (2020). *Food packaging: Advanced materials, technologies, and innovations*. CRC Press.
14. Food Science Source. (n.d.). Retrieved from https://www.ebsco.com/products/research-databases/food-science-source
15. BRCGS. (n.d.). *Global standard for food safety issue 9*. Retrieved from https://www.brcgs.com/our-standards/food-safety/issue-9-revision/
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21. Jaiswal, A. K. (Ed.). (2020). *Nutritional composition and antioxidant properties of fruits and vegetables*. Academic Press.
22. Jongen, W. (Ed.). (2002). *Fruit and vegetable processing: Improving quality*. Woodhead Publishing.
23. Lim, T. K. (2012). *Edible medicinal and non-medicinal plants: Volume 1, fruits*. Springer.

24. Lozano, J. E. (Ed.). (2006). *Fruit manufacturing: Scientific basis, engineering properties, and deterioration behavior*. Springer.
25. Marco, M. L., Heeney, D., Binda, S., Cifelli, C. J., Cotter, P. D., Foligné, B., Gänzle, M., Kort, R., Pasin, G., Pihlanto, A., Smid, E. J., Hutkins, R., & Ventura, M. (2017). Health benefits of fermented foods: Microbiota and beyond. *Current Opinion in Biotechnology, 44*, 94–102. https://doi.org/10.1016/j.copbio.2016.11.010
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27. Mérillon, J.-M., & Ramawat, K. G. (Eds.). (2018). *Bioactive molecules in food*. Springer.
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37. Saravacos, G. D., & Kostaropoulos, A. E. (2016). *Handbook of food processing equipment* (2nd ed.). Springer.
38. Shahidi, F. (Ed.). (2005). *Bailey's industrial oil and fat products* (6th ed., Vols. 1–6). Wiley-Interscience.
39. Silva, C. L. M., & Oliveira, F. A. R. (Eds.). (2008). *Thermal food processing: New technologies and quality issues*. CRC Press.
40. Sinha, N. K., Hui, Y. H., Evranuz, E. Ö., Cano, M. P., Barta, J., & Siddiqi, J. I. (Eds.). (2012). *Handbook of fruits and fruit processing* (2nd ed.). Wiley-Blackwell.
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47. Yahia, E. M. (Ed.). (2019). *Postharvest physiology and biochemistry of fruits and vegetables*. Woodhead Publishing.
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Materials needed for the implementation of the study course program

No.	Material resources and equipment	Quantity / description
1	Laboratory equipment, refrigerators, freezers, canning and drying equipment, scales, thermometers etc.	Equipment for demonstration and practical training
2	Kitchen equipment for conducting practical classes on preparing dishes from fruits and vegetables.	Equipment for demonstration and practical training
3	Chemicals, acids and alkalis for canning, indicators for measuring pH and others.	Equipment for demonstration and practical training
4	Digital refractometer	1 (at least)
5	pH meter	1 (at least)
6	Light microscope	1 (at least)
7	Structure analyser	1
8	Vacuum cooker	1
9	Convective dryer	3
10	Freeze-dryer	1
11	Microwave vacuum dryer	1
12	Flash freezer	1
13	Contact plate freezer	1
14	Thermostat	3
15	Slow rotation type juicer	1
16	Steamer	1
17	Evaporation of juice in a diffusion pot	1
18	Mechanical juicer	1
19	Sterilizer (autoclave)	1
20	Colour analyser	1
21	Gas composition detector	1

22	Bag mixer	Solid sample homogenizer for microbiology – 1
23	Deep fryer	1
24	Rotary-type vacuum evaporator	1

Methods used for the implementation of the study course program

No.	Types	Methods possible to be applied
1	Interactive tools	Use of interactive technologies and educational programs to educate students, such as computer simulations, virtual laboratories, and online courses.
2	Lectures	Presentation of theoretical material by the teacher. Lectures may include basic concepts, principles and technologies of the studied theme.
3	Laboratory works	Working with equipment and tools, conducting experiments, tasting and analysing fruit and vegetable samples and their product samples. Practical classes help students consolidate theoretical knowledge in practice.
4	Seminars	Compilation and explanation of the data obtained in laboratory work with theoretically learned material, clarifying the differences. Analysis of problem situations from the point of view of the fruit and vegetable processing industry