



Theofilos Frangopoulos

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Date of birth: 20/08/1994 **Place of birth**: Thessaloniki **Nationality**: Greek

EDUCATION AND TRAINING

[20/12/2020 – 30/08/2024]

Doctor of Philosophy, PhD

International Hellenic University, Department of Food Science and Technology <https://www.food.ihu.gr/>

Address: 57400, Thessaloniki, Greece | **Field(s) of study**: Food Science and Technology | **Final grade**: Excellent | **Level in EQF**: EQF level 8 | **National classification**: 8 | **Thesis**: Active biodegradable food packaging based on starch – bioactive compounds molecular complexes and nanoclay

[23/12/2018 – 25/05/2020]

Master's Degree in Food Science and Nutrition

Aristotle University of Thessaloniki, Department of Agriculture food-science.agro.auth.gr

Field(s) of study: Food Science and Technology | **Final grade**: 9,14/10 | **Level in EQF**: EQF level 7 | **National classification**: 7 | **Type of credits**: ECTS | **Number of credits**: 60 | **Thesis**: Exploitation of Trigonella Foenum – Grecum seeds in meat emulsions

[15/09/2012 – 10/11/2017]

Integrated Master's Degree

Aristotle University of Thessaloniki, Department of Agriculture agro.auth.gr

Address: 57001, Thessaloniki, Greece | **Field(s) of study**: Επιστήμη και Τεχνολογία Τροφίμων | **Level in EQF**: EQF level 7 | **National classification**: 7 | **Type of credits**: ECTS | **Number of credits**: 291

WORK EXPERIENCE

Department of Food Science and Technology - International Hellenic University <https://www.food.ihu.gr/>

City: Thessaloniki | **Country**: Greece | **Email**: info@food.ihu.gr | **Name of unit/department**: Food Science and Technology | **Business/sector**: Education

[04/11/2024 – Current]

Post Doc Researcher

Dr. Frangopoulos will continue his postdoctoral research from November 2024 until November 2027

on the topic of "Applications of biodegradable

food packaging with complexed bioactive substances – Improving properties and increasing

applicability in industry" at the Department of Food Science and Technology of the International

University of Greece under the supervision of Associate Professor Vasileios Karageorgiou. The main axes of his postdoctoral

research are

--> the evaluation of the effect of the container on the surface properties of the produced starch-based biodegradable film.

--> the production of starch-based biodegradable films with more than one

complexed bioactive substance and how this affects the shelf life of perishable

foods.

--> improving the barrier properties of biodegradable starch-based films against moisture and oxygen

--> the production of biodegradable starch-based films using a thermal extruder with the aim of enabling continuous industrial production

--> a comprehensive study of the migration of substances from biodegradable starch-based films,

with a view to harmonisation with European and international regulations.

Department of Agriculture, University of Ioannina <https://dagri.uoi.gr/>

City: Arta | **Country:** Greece | **Email:** deagri@uoi.gr | **Name of unit/department:** Agriculture | **Business/sector:** Education

[04/10/2024 – Current] **Fixed Term Professor (ESPA)**

International Hellenic University

City: Thessaloniki | **Country:** Greece | **Email:** food-diaviou@food.ihu.gr | **Name of unit/department:** Food Science and Technology | **Business/sector:** Education

[20/02/2024 – 10/05/2024]

Instructor of KDBM educational seminars "Seminars on Meat Processing and Meat Product Preparation"

International Hellenic University

City: Thessaloniki | **Country:** Greece

[05/11/2020 – 30/09/2023]

Researcher - Active Biodegradable Starch-Based Food Packaging - (StActBioFP)

Aliment Lab

City: Thessaloniki | **Country:** Greece

[05/04/2018 – 10/09/2018]

Research and Development (RnD)

PROVIL S.A.

City: Thessaloniki | **Country:** Greece

[01/07/2017 – 31/08/2017]

Research and Development (RnD)

FRANGOPOULOS J. THEOFILOS

City: Thessaloniki | **Country:** Greece

[05/11/2020 – Current]

Food Science Research Services

HACCP, ISO Standards

Filakis Meat Company

City: Thessaloniki | **Country:** Greece

[10/04/2014 – Current]

Quality Assurance Section - RnD

LANGUAGE SKILLS

Mother tongue(s): Greek

Other language(s):

Αγγλικά

LISTENING C2 READING C2 WRITING C2

SPOKEN PRODUCTION C2 SPOKEN INTERACTION C2

French

LISTENING A2 READING A2 WRITING A2

SPOKEN PRODUCTION A2 SPOKEN INTERACTION A2

Levels: A1 and A2: Basic user - B1 and B2: Independent user - C1 and C2: Proficient user

SKILLS

EXCEL | POWERPOINT | MICROSOFT OFFICE | Matlab Mathematica Maxima |
Statistical Analysis Software JMP

PUBLICATIONS

[2020] [Development of low fat: Low salt processed meat products](#)

Reference: Frangopoulos Theofilos et al.

There is a growing demand for the development of healthier meat products with reduced fat and salts. The present study was carried out to develop low fat - low salt processed meat products in a type of fermented sausages. Products were formulated with different fat contents (10 g/100g - 20 g/100g) and levels of sodium chloride (0-2 g/100g) and potassium chloride (0-1 g/100g). Potassium chloride (KCl) was used as a substitute for sodium chloride (NaCl). Physicochemical characteristics and textural attributes were assessed instrumentally, while sensory attributes were determined using Quantitative Descriptive Analysis and Principal Component Analysis. The instrumental analysis showed significant ($p < 0.05$) differences in hardness, brittleness, cohesiveness and chewiness among different sausage formulations. However, sensory analysis did not detect any textural changes due to salt substitution or fat reduction. The product with the highest fat content and KCl substitution was found to have the highest rating of perceived bitterness. The research findings identified the significant interaction between the addition of KCl and the fat content on bitterness perception.

[2021] [Incorporation of Trigonella Foenum-Graecum seed powder in meat emulsion systems with olive oil: effects on physicochemical, texture, and color characteristics](#)

Reference: T. Frangopoulos

Six meat emulsion treatments were manufactured, depending on the addition of Trigonella seed powder. Meat emulsions were prepared with starch as control treatment, Trigonella seed powder (Tfg) or defatted Trigonella seed powder (Dtfg) in two percentages 2% and 4%. Cooking losses, lipid oxidation degree, meat emulsion stability through measurement of total released fluid, water released, fat released, TPA attributes and color parameters were evaluated. Cooking loss and fat, fluid releases were lower in Tfg and Dtfg samples related to Starch. Also, lipid oxidation was higher ($P < 0,05$) in Tfg samples than Dtfg or Starch. Hardness, chewiness and gumminess were lower ($P < 0,05$) in Tfg and Dtfg samples than Starch samples. The a^* values in samples with starch were reduced rapidly ($P < 0,05$) than Tfg and Dtfg values during preservation. These results show that *Trigonella Foenum-Graecum* seed powder is an efficient candidate for improving quality of emulsion type meat products with vegetable oils as animal fat replacers.

[2022] [A Green, Efficient Approach on Extraction of Polyphenols from Fenugreek Seeds \(Trigonella foenum-graecum\): DES and \$\beta\$ -Cyclodextrin Assisted Extraction](#)

Reference: T. Frangopoulos

Trigonella foenum-graecum, is a widely used medicinal and culinary plant. The antioxidant compounds extracted from the seeds of this plant exert antioxidant, anti-inflammatory, and hypoglycemic effects. In this study, antioxidant compounds from the seeds of *Trigonella foenum-graecum* were obtained using the deep eutectic solvent (DES) assisted and β -cyclodextrin assisted extraction method. The process was optimized by implementing a response surface methodology that took into consideration the following independent variables: β -cyclodextrin concentration (C β -CD) or DES concentration, solid-to-liquid ratio, and temperature. Based on the results from single-factor experiments, response surface methodology was used to optimize the extraction conditions. The scavenging activity of *Trigonella foenum-graecum* antioxidant compounds on DPPH*, the total phenolic yield (YTP) and total flavonoid yield (YTF) was determined. Using the optimized conditions for DES extractions, the yields were 0.019 mmol TRE/g seed, 14.73 mg GAE/g seed and 0.092 mmol QE/g seed for AAR, YTP and YYF respectively. For β -cd assisted extraction, using the optimized conditions, the yields were 0.1213 mmol TRE/g seed, 12.89 mg GAE/g seed and 0.1602 mmol QE/g seed for AAR, YTP and YYF respectively. However, based on regression analysis and optimization based on solvent type it is observed that the extraction yield with β -cyclodextrin solutions is statistically significantly ($P < 0.05$) higher than the corresponding yield with solutions of deep eutectic solvent mixtures.

[2022] [**Incorporation of Trigonella Foenum-Graecum Seed Powder in Nitrite-Free Meat Emulsion Systems with Olive Oil: Effects on Color Stability**](#)

Reference: T. Frangopoulos

The replacement of nitrites and starch from *Trigonella* seed powder in the percentage of myoglobin and metamyoglobin as well as in the color factors (L*, a*, b*) in meat emulsions with olive oil was evaluated. The meat emulsions were prepared on the basis of complete replacement of sodium nitrite (NaNO₂) and starch with *Trigonella* seed powder, where the fat was removed by the Soxhlet method. Thus, two samples emerged, namely, the first sample that was the control and contained 3% starch and sodium nitrite (Starch + NaNO₂) in the amount of 150 ppm and the second sample containing *Trigonella* at 3% (Dtfg) where the fat was removed by the Soxhlet method. The Dtfg sample had a higher percentage of oxymyoglobin ($P < 0.05$) throughout the maintenance period and lower percentages of metamyoglobin ($P < 0.05$) up to the fifth day of maintenance compared to the Starch + NaNO₂ sample. The factors L* (brightness) and a* (red color) decreased more strongly in the Starch + NaNO₂ sample compared to the Starch + NaNO₂ sample.

[2023] [**Optimizing the Functional Properties of Starch-Based Biodegradable Films**](#)

Reference: Theofilos Frangopoulos, Anna Marinopoulou, Athanasios Goulas, Eleni Likotrafiti, Jonathan Rhoades, Dimitrios Petridis, Eirini Kannidou, ..., Vassilis Karageorgiou

A definitive screening design was used in order to evaluate the effects of starch, glycerol and montmorillonite (MMT) concentrations, as well as the drying temperature, drying tray type and starch species, on packaging film's functional properties. Optimization showed that in order to obtain films with the minimum possible thickness, the maximum elongation at break, the maximum tensile strength, as well as reduced water vapor permeability and low opacity, a combination of factors should be used as follows: 5.5% wt starch concentration, 30% wt glycerol concentration on a dry starch basis, 10.5% wt MMT concentration on a dry starch basis, 45 °C drying temperature, chickpea as the starch species and plexiglass as the drying tray type. Based on these results, starch films were prepared, and fresh minced meat was stored in them for 3 days. It was shown that the incorporation of MMT at 10.5% wt on a dry starch basis in the packaging films led to a decreased mesophilic and psychrotrophic bacteria growth factor compared to commercial packaging. When assessed for their biodegradability, the starch films

disintegrated after 10 days of thermophilic incubation under simulated composting conditions. Finally, to prove their handling capability during industrial production, the starch films were rewound in a paper cylinder using an industrial-scale rewinding machine

[2023] [Sodium Trimetaphosphate Crosslinked Starch Films Reinforced with Montmorillonite](#)

Reference: Konstantinos Noulis, Theofilos Frangopoulos, Athanasia Arampatzidou, Lazaros Tsekmes, Anna Marinopoulou, Athanasios Goulas, Vassilis Karageorgiou

Synthetic polymers are the main food packaging material, although they are nonbiodegradable and their recycling process is expensive. A biodegradable, eco-friendly material, with high availability and low cost, such as starch, is a promising solution for the production of films for food packaging. To enhance starch film mechanical and barrier properties, nanoclays have been incorporated within the film matrix. Crosslinking is a well-established method to modify starch properties, but it has not been investigated in combination with nanoclay addition. In the present study, films were developed with starch that was crosslinked through the addition of 5, 15, and 40% wt. sodium trimetaphosphate (STMP) based on dry starch weight. To investigate the interaction between crosslinking and nanoclay addition, montmorillonite (MMT) was added at a 10.5% wt. concentration based on dry starch weight. Experimental data revealed a synergistic effect between STMP crosslinking and MMT addition regarding film thickness, elongation at break, color properties, and opacity. Regarding barrier properties, MMT addition negated the effect of STMP crosslinking, while, in the case of moisture content, it did not alter the effect of STMP crosslinking. Finally, in the case of tensile strength, a synergistic effect followed by a negative interaction was observed. In conclusion, the addition of MMT can potentially enhance, alongside crosslinking, some properties of the films, while other properties are not affected any more than just by crosslinking.

[2024] [Assessing the Fatigue Stress Behavior of Starch Biodegradable Films with Nanoclay Using Accelerated Survival Test Methods](#)

Reference: Theofilos Frangopoulos, Sophia Dimitriadou, Joanis Ozuni, Anna Marinopoulou, Athanasios Goulas, Dimitrios Petridis, Vassilis Karageorgiou

A destructive degradation model was applied on films made from different concentrations of starch, glycerol and nanoclay using various elongation levels as a stress variable at different stress times and stretch cycles. The log tensile quotient (logarithm of the tensile strength to the corresponding break cycle) was recorded as the response variable. The log tensile quotient increased, and the log exact break time decreased, as the elongation level increased. The treatment containing the highest starch and nanoclay and lowest glycerol content proved to be the most resistant to stress conditions and the most versatile in relation to the varying log tensile quotients, while the treatments containing the lowest nanoclay and highest glycerol contents, regardless of the starch concentration, manifested the lowest log tensile quotient at higher levels of log exact break time. According to multiple regression findings, the break cycle governed mostly the stress conditions in the degradation model, followed by the sample ID and the log exact break time. The term log tensile quotient, attempted for the first time on data concerning biodegradable films enhanced with nanoclay, seems very promising for deeper research due to its ability to retrieve predictive information from survival equations and to discriminate the difference between film structures.

[2024] [Accelerated Life Testing of Biodegradable Starch Films with Nanoclay Using the Elongation Level as a Stressor](#)

Reference: Theofilos Frangopoulos, Apostolos Ketesidis, Anna Marinopoulou, Athanasios Goulas, Dimitrios Petridis, Vassilis Karageorgiou

An attempt was made to evaluate the elongation level as a stressor on biodegradable starch films reinforced with nanoclay using a simple linear model. A total of 120 film units were subjected to increasing elongation levels and the exact break time of the failed units was monitored. Nine different attempts were made to fit the data distribution and the lognormal distribution was chosen as the most suitable because it resulted in the lowest values of the regression fit indices $-2LL$, AICc and BIC. Following the selection of the best fit, it was, generally, observed that an increase in the elongation level resulted in the decreasing exact break time of the films. Among several models, the best fit was provided by the simple linear model. Based on this model, the acceleration factor was estimated, and it was shown that it increased exponentially while increasing the elongation level. Finally, the probability of failure and the hazard rate of the film units as a function of the elongation level were estimated, demonstrating the applicability of this method as a tool for food packaging film failure prediction.

The Effect of Accelerated Storage Temperature Conditions on the Shelf Life of Pasteurized Orange Juice Based on Microbiological, Physicochemical, and Color Attributes

[2024]

Reference: Theofilos Frangopoulos, Antonios Kolioukas, Dimitris Petridis

The accelerated life testing (ASLT) method was used to evaluate the effect of increasing the storage temperature from 10 to 40 °C on the aerobic plate count (APC), the pH, and the colorimetric parameters (L^* , a^* , b^*) of pasteurized orange juice during 40 days of storage. For APC growth, a polynomial model was found to fit better, and at the lower temperatures of 10 and 15 °C, the shelf life was longer, as expected. More specifically, 15 and 10 days were needed, respectively, until the rise in the APC population to 1000 cfu/mL. However, for the temperature range of 30–40 °C, only approximately 3 days were needed to reach 1000 cfu/mL APC. Regarding pH, according to an exponential 3P model, a stable trend was apparent at all temperatures until 30 days of storage, followed by a more abrupt decreasing trend at 25 °C. The lightness (L^*), redness (a^*), and yellowness (b^*) of the juice showed a decreasing trend with the temperature increase, and this trend was more profound at higher temperature levels. The multiple regression analysis between the predictors L^* , a^* , b^* , pH, storage temperature, and the APC response showed an increase in APC growth when the colorimetric parameters decreased and the temperature increased.

Films from Starch Inclusion Complexes with Bioactive Compounds as Food Packaging Material

[2025]

Natural polymers are an alternative to plastics in food packaging applications due to their biodegradability, and starch is a promising candidate due to its abundance and low cost. Furthermore, amylose has the ability to form inclusion complexes with bioactive compounds, ensuring their stability; nevertheless, this property has not been exploited in food packaging applications. In the present study, films from starch inclusion complexes with bioactive compounds (carvacrol and ascorbic acid) were developed and tested as food packaging material. The formation of starch inclusion complexes resulted in films with enhanced tensile strength, without compromising their flexibility, water vapor permeability, and transparency. Fresh minced meat was packaged in films from starch inclusion complexes with bioactive compounds and refrigerated for 4 days. Films from starch inclusion complexes with ascorbic acid had the highest antioxidant activity, resulting in the most appealing color properties, while films from starch inclusion complexes with carvacrol had the highest antimicrobial activity, resulting in smaller increases in aerobic plate and psychrotrophic count. Consequently, the formation of

starch inclusion complexes with bioactive compounds is a promising technology for the development of biodegradable, active food packaging materials.

Authors: Theofilos Frangopoulos, Anna Marinopoulou, Dimitrios Petridis, Jonathan Rhoades, Eleni Likotrafiti, Athanasios Goulas, Sofiela Fetska, Domna Flegka, Evaggelia Mati, Alexandra Tosounidou, Vera Triantafillou,....., Vassilis Karageorgiou | **Journal Name:** Food and Bioprocess Technology | **Publisher:** Springer Nature

[2025] [**Sensory Shelf Life of Pasteurized Orange Juice Stored Under Different Temperature Levels Using Inverse Time Sampling and a Balanced Incomplete Block Design**](#)

The sensory acceptability rate of pasteurized orange juices stored at different temperature levels was evaluated using a large-scale experiment with untrained consumers and an accelerated shelf-life testing method. Pasteurized orange juice samples were stored at 10, 20, 30 and 40 °C and tested for acceptance or rejection at consecutive time points using a reverse product preservation plan. From a total of 504 samples and the participation of 72 consumers, 155 failures and 109 passes were recorded. Due to the large number of samples (28) selected for testing from each consumer, a balanced incomplete block design was adopted to facilitate a very small number for evaluation (7 for each consumer) with minimal reduction in the reliability of the experiment and results. As expected, there was a gradual increasing trend of rejections at all temperature levels by time. Also, it was observed that pasteurized orange juices tended to be rejected by consumers at approximately 3 days before they would be microbiologically unsafe for consumption. Also, it was shown from the risk rate trend that higher storage temperatures are linked with very early perceptiveness of sensory defects during nearly the first 100 h of preservation. The present work constitutes essentially a very useful tool for the industry because it enables the proper adjustment of shelf life including both sensory and microbiological parameters, which results in fewer returned and deteriorated products.

Authors: Theofilos Frangopoulos, Antonios Kolioukas, Dimitris Petridis | **Journal Name:** Applied Sciences | **Publisher:** MDPI

[2025] [**The Physicochemical, Textural and Sensory Properties of Traditional Sausages Made with Greek Buffalo Meat and Fat Using a Particular Mixture Design**](#)

Applying a statistical mixture design, 10 different blending combinations of traditional Greek sausages were prepared based on different percentages of the three ingredients (buffalo meat: 40–70%; pork fat: 0–30%; buffalo fat: 0–30%). Samples were then analyzed for chemical composition, instrumental textural properties and sensory attributes, using a balanced incomplete block design (BIBD) for the sensory analysis. According to the chemical set, the fat content increased when both fat origins increased, and the protein content also increased when the proportion of buffalo meat increased in the formulations. Regarding textural properties, an instrumental analysis revealed a positive relationship between fat level increases and hardness, whereas a sensory analysis revealed a rise in hardness when the proportion of buffalo fat increased, but that was not observed for sensory juiciness. A hierarchical cluster analysis and PCA revealed a strong relationship between the elasticity, juiciness and overall acceptability of samples with high fat contents, regardless of the origin of the fat, whereas at the same time, a strong relationship was found between high buffalo meat contents (70%) in samples and both instrumental and sensory hardness, chewiness and protein content.

Authors: Theofilos Frangopoulos, Dimitris Petridis, Eirini Didaskalou, Eleni Tzika | **Journal Name:** Applied Sciences | **Publisher:** MDPI

[2025] [**On the Rheological Memory and Cumulative Damage of Thermoplastic Starch Biodegradable Films Reinforced with Nanoclay**](#)

Although the strain hardening phenomenon has been studied in different types of materials, there are only a few such reports regarding flexible food packaging. To address this issue, nanoclay-reinforced and control starch-based films were subjected to sequential and weekly tension and the rheological index, defined as the ratio of the tensile strength observed under weekly to that under consecutive elongation, was measured. The results showed that the values of the rheological index were >1 , implying a strain hardening effect that was more notable when nanoclay was added and when the stress duration was increased. Additionally, a cumulative damage test was conducted, involving the gradual increase of two factors in each step: the percentage of the elongation level and the duration of each step. The data were fitted to a linear model, describing the correlation between the \ln failure time (μ) and the tensile strength (X), $\mu = 6.021 - 0.478 X$. This model enabled the prediction of the failure probability and the hazard rate of the films that were studied. In addition, from the survival of the units in the initial steps of the cumulative damage experiment, it can be hypothesized that the elongation of the units under low stress levels, for prolonged periods of time, exhibits rheological memory properties, which leads to an increase in their mechanical strength.

Authors: Eleni Kazantzi, Melpomeni Christou, Theofilos Frangopoulos, Anna Marinopoulou, Athanasios Goulas, Dimitrios Petridis, Vassilis Karageorgiou | **Journal Name:** Applied Sciences MDPI | **Publisher:** MDPI

CONFERENCES & SEMINARS

[22/11/2022]

Incorporation of Trigonella Foenum-Graecum Seed Powder in Nitrite-Free Meat Emulsion Systems with Olive Oil: Effects on Color Stability

Athens, Greece

- 10th Conference of Greek Lipid Forum

Poster Presentation

[23/03/2023 – 25/03/2023]

Frangopoulos T., Petridis D., Marinopoulou A., Goulas A., Kannidou E., Ketesidis A., Ozouni G., Dimitriadou S., Arampatzidou A., Tsekmes L., Koulaki E., Lioli A., Georgiou D., Kalogianni E., Raphaelides S., Karageorgiou V.: Optimization of starch based biodegradable films manufactured with montmorillonite, focusing on mechanical, barrier and physicochemical properties.

Rome, Italy

2nd Global Summit on Food Science and Technology

[05/07/2023 – 07/07/2023]

Assessing the fatigue stress behavior of starch biodegradable films with montmorillonite using accelerated survival test methods

Paris, France

- International ISEKI-Food Conference

Poster Presentation

[05/07/2023 – 07/07/2023]

Marinopoulou A., Sotiriadou P., Karamarkou M., Frangopoulos T., Karageorgiou V., Raphaelides S., Goulas A.: Biodegradable spray dried starch-based films reinforced with silicon dioxide.

Paris, France

7th International ISEKI-Food Conference

[29/05/2024 – 31/05/2024]

Frangopoulos T., Petridis D., Marinopoulou A., Goulas A., Ketesidis A., Koulaki E., Lioli A., Raphaelides S., Karageorgiou V.: Accelerated life testing of starch biodegradable films with nanoclay using the elongation level as stressor.

Thessaloniki

14th Panhellenic Scientific Conference on Chemical Engineering

[29/05/2024 – 31/05/2024]

**Karageorgiou V., Noulis K., Frangopoulos T., Arampatzidou A., Tsekmes L.,
Marinopoulou A., Goulas A.: Sodium trimetaphosphate crosslinked starch films
reinforced with montmorillonite.**

Thessaloniki

14th Panhellenic Scientific Conference on Chemical Engineering

**ΠΑΤΕΝΤΕΣ/ΔΙΠΛΩΜΑΤΑ
ΕΥΡΕΣΙΤΕΧΝΙΑΣ**

**Process for incorporating Trigonella Foenum-Graecum seed powder into meat-
based products with edible oils**

Karageorgiou V., Goulas A., Marinopoulou A., Frangopoulos T., Raphaelides S..

**Production of Biodegradable Flexible Packaging Materials with Predetermined
Functional Characteristics**