ΗΜΕΡΙΔΑ

ΚΑΙΝΟΤΟΜΕΣ ΤΕΧΝΙΚΕΣ ΑΛΙΕΥΣΗΣ, ΕΠΕΞΕΡΓΑΣΙΑΣ ΚΑΙ ΣΥΣΚΕΥΑΣΙΑΣ ΓΙΑ ΤΗ ΒΕΛΤΙΩΣΗ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΚΑΙ ΤΗΣ ΔΙΑΤΗΡΗΣΙΜΟΤΗΤΑΣ ΦΡΕΣΚΩΝ ΠΡΟΪΟΝΤΩΝ ΙΧΘΥΟΚΑΛΛΙΕΡΓΕΙΑΣ

Πέτρος Ταούκης
Καθηγητής ΕΜΠ

Slurry Fish

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Θάλασσας και Αλιείας
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Υπουργείο Αγροτικής Ανάπτυξης και Τροφίμων
Ε.Π. ΑΛΙΕΙΑΣ ΚΑΙ ΘΑΛΑΣΣΑΣ 2014 - 2020
ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

Πέμπτη 26 Μαΐου 2022
Αμφιθέατρο Πολυμέσων| Κεντρική Βιβλιοθήκη ΕΜΠ
Πολυτεχνειούπολη Ζωγράφου

ΠΡΟΓΡΑΜΜΑ ΗΜΕΡΙΔΑΣ

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Θάλασσας και Αλιείας

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Ε.Π. ΑΛΙΕΙΑΣ ΚΑΙ ΘΑΛΑΣΣΑΣ 2014 - 2020

ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

WORKSHOP

ΚΑΙΝΟΤΟΜΕΣ ΤΕΧΝΙΚΕΣ ΑΛΙΕΥΣΗΣ, ΕΠΕΞΕΡΓΑΣΙΑΣ ΚΑΙ ΣΥΣΚΕΥΑΣΙΑΣ ΓΙΑ ΤΗ ΒΕΛΤΙΩΣΗ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΚΑΙ ΤΗΣ ΔΙΑΤΗΡΗΣΙΜΟΤΗΤΑΣ ΦΡΕΣΚΩΝ ΠΡΟΪΟΝΤΩΝ ΙΧΘΥΟΚΑΛΛΙΕΡΓΕΙΑΣ

Πέμπτη 26 Μαΐου 2022

Αμφιθέατρο Πολυμέσων Κεντρική Βιβλιοθήκη ΕΜΠ | Πολυτεχνειούπολη Ζωγράφου

ΠΡΟΓΡΑΜΜΑ

09:00-09:30	**ΠΡΟΣΕΛΕΥΣΗ**
09:30-10:00	Χαιρετισμοί – Εισαγωγή και Παρουσίαση των Ερευνητικών Δραστηριοτήτων Καινοτόμες τεχνικές αλίευσης, επεξεργασίας και συσκευασίας για τη βελτίωση της ποιότητας και της διατηρησιμότητας φρέσκων προϊόντων ιχθυοκαλλιέργειας ***ΠΕΤΡΟΣ Σ. ΤΑΟΥΚΗΣ**, Καθηγητής ΕΜΠ*
10:00-10:30	Μελέτη και εφαρμογή καινοτόμων μεθόδων στα στάδια της αλίευσης και της επεξεργασίας για τη βελτίωση της ποιότητας και της διατηρησιμότητας των ιχθυηρών ***ΑΘΗΝΑ ΝΤΖΙΜΑΝΗ**, Μεταδιδακτορική Ερευνήτρια, Εργαστήριο Χημείας και Τεχνολογίας Τροφίμων (ΕΜΠ)* ***ΘΕΟΦΑΝΙΑ ΤΣΙΡΩΝΗ**, Επίκουρη Καθηγήτρια ΓΠΑ*
10:30-11:00	Η γενετική βάση της φρεσκότητας – αλληλεπίδραση με τις τεχνικές αλίευσης ***ΡΑΦΑΗΛ ΑΓΓΕΛΑΚΟΠΟΥΛΟΣ**, Υπ. Διδάκτωρ, Εργαστήριο Γενετικής, Συγκριτικής & Εξελικτικής Βιολογίας (ΠΘ)*
11:00-11:15	**ΔΙΑΛΕΙΜΜΑ – ΚΑΦΕΣ**
11:15-11:45	Εφαρμογή Καινοτόμου Τεχνολογίας Ψυχρού Πλάσματος για την Παραγωγή φιλέτων ιχθυηρών υψηλής ποιότητας και με αυξημένο χρόνο ζωής ***ΓΕΩΡΓΙΟΣ ΚΑΤΣΑΡΟΣ**, Ερευνητής Γ', ΙΤΑΠ – ΕΛΓΟ ΔΗΜΗΤΡΑ*
11:45-12:15	Εφαρμογή ήπιας επεξεργασίας με Υπερυψηλή Πίεση σε φιλέτα ιχθυηρών για μείωση του μικροβιακού φορτίου ***ΜΑΡΙΑ ΤΣΕΒΔΟΥ**, Μεταδιδακτορική Ερευνήτρια, Εργαστήριο Χημείας και Τεχνολογίας Τροφίμων (ΕΜΠ)*
12:15-12:45	Εφαρμογή έξυπνης και ενεργής συσκευασίας ιχθυηρών και ανάπτυξη καινοτόμου συστήματος διαχείρισης και διασφάλισης υψηλής ποιότητας και βελτιωμένης διατηρησιμότητας ***ΕΛΕΝΗ ΓΩΓΟΥ**, Επίκουρη Καθηγήτρια ΠΘ* ***ΜΑΡΙΑ ΚΑΤΣΟΥΛΗ**, Μεταδιδακτορική Ερευνήτρια, Εργαστήριο Χημείας και Τεχνολογίας Τροφίμων (ΕΜΠ)*
12:45-13:15	Προσδιορισμός των απαιτήσεων των καταναλωτών αναφορικά με τη φρεσκότητα και την ποιότητα των ιχθυηρών ***ΚΡΙΤΩΝ ΓΡΗΓΟΡΑΚΗΣ**, Ερευνητής Α', Ελληνικό Κέντρο Θαλασσίων Ερευνών (ΕΛ.ΚΕ.Θ.Ε.)* ***ΕΥΑΓΓΕΛΙΑ ΝΑΝΟΥ**, Ερευνήτρια, Ελληνικό Κέντρο Θαλασσίων Ερευνών (ΕΛ.ΚΕ.Θ.Ε.)*
13:15-13:45	Η ιχθυοκαλλιέργεια στην Ελλάδα – Προκλήσεις και δυνατότητες για το παρόν και το μέλλον ***ΝΙΚΟΛΑΟΣ ΛΥΜΠΕΡΗΣ**, Διευθύνων Σύμβουλος PHILOSOFISH A.E.* ***ΚΩΝΣΤΑΝΤΙΝΟΣ ΤΖΟΚΑΣ**, Διευθυντής Έρευνας & Ανάπτυξης AVRAMAR A.E.*
13:45-14:15	**ΣΥΖΗΤΗΣΗ & ΣΥΜΠΕΡΑΣΜΑΤΑ – ΕΛΑΦΡΥ ΓΕΥΜΑ**

Παραγωγη Τσιπουρας & Λαβρακιου

The EU imports SBSB to meet consumer demand. Key consuming countries include Spain, Portugal, Greece, Italy and the UK, and the world-leading producer and non-EU exporting country is Turkey. According to the Turkish Statistical Institute (Turkstat), Turkish production in 2018 reached 116,915 tonnes for sea bass and 76,680 tonnes for sea bream. The UK, and to a lesser extent Austria, are leading European export markets for Turkish SBSB.*

was

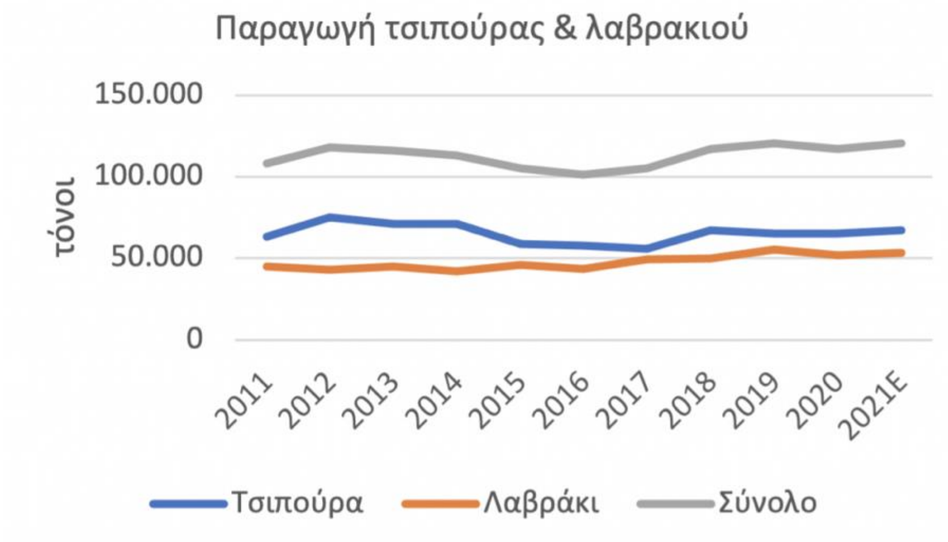
86%

INCREASE IN GLOBAL PRODUCTION OF FARMED EUROPEAN SEA BASS AND

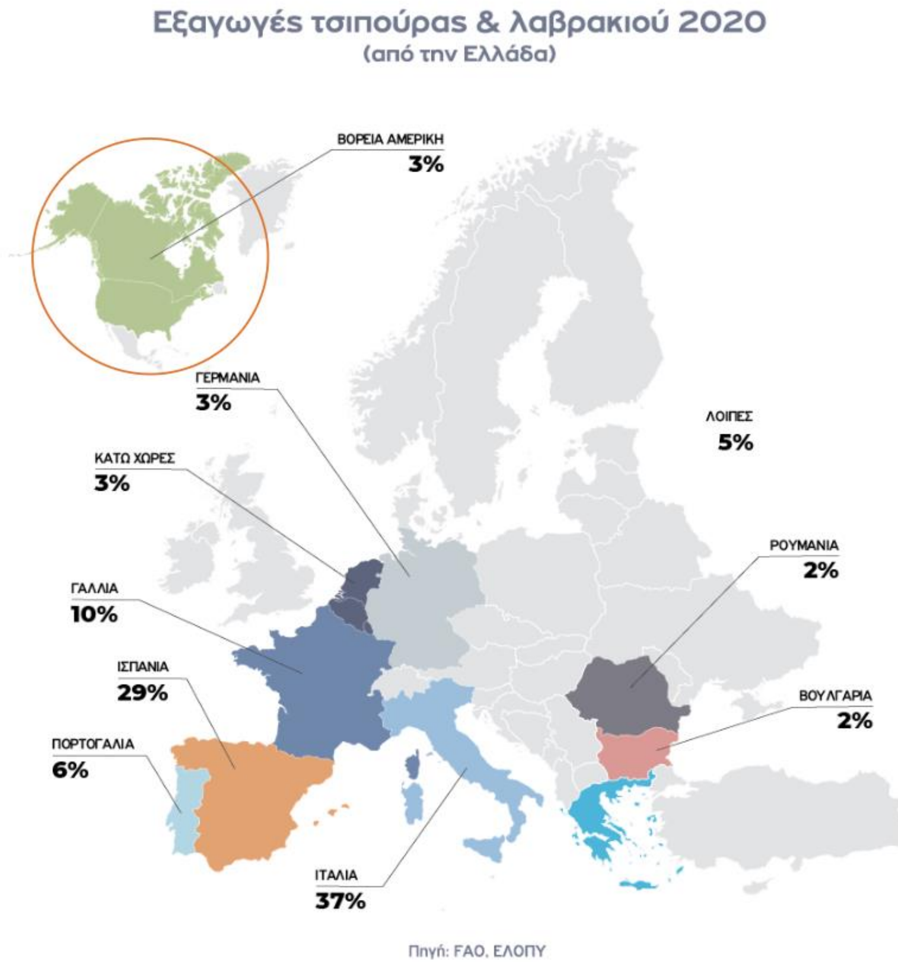
68%

INCREASE OF FARMED GILTHEAD SEA BREAM BETWEEN 2008 AND 2017

Παραγωγη Τσιπουρας & Λαβρακιου στην Ελλαδα

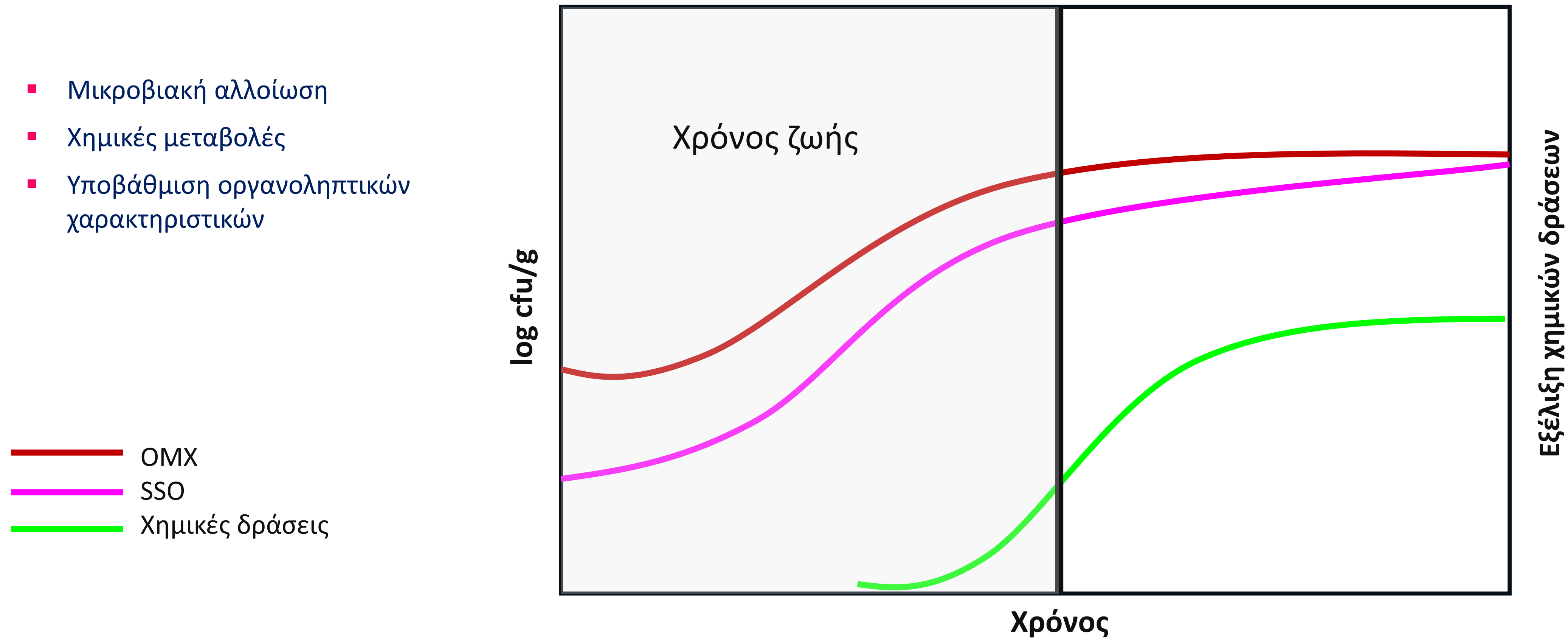


ΕΛΟΠΥ
ΕΛΛΗΝΙΚΗ ΟΡΓΑΝΩΣΗ ΠΑΡΑΓΩΓΩΝ ΥΔΑΤΟΚΑΛΛΙΕΡΓΕΙΑΣ



Ευαλλοιωτη Φυση των Ιχθυηρων

- Μικροβιακή αλλοίωση
- Χημικές μεταβολές
- Υποβάθμιση οργανοληπτικών χαρακτηριστικών



Παραγοντες που Καθοριζουν την Ποιοτητα της Σαρκας των Εκτρεφομενων Ιχθυων

- Χαρακτηριστικά ιχθύων (είδος, ηλικία, φύλο, υγεία)
- Συνθήκες εκτροφής (σύσταση σιτηρεσίου, συχνότητα)
- Περιβαλλοντικές συνθήκες (ποιότητα ύδατος, θερμοκρασία, φως, οξυγόνο, παθογόνοι, παράσιτα)
- **Αλίευση**
  Επεξεργασία
  Διακίνηση
  Συντήρηση

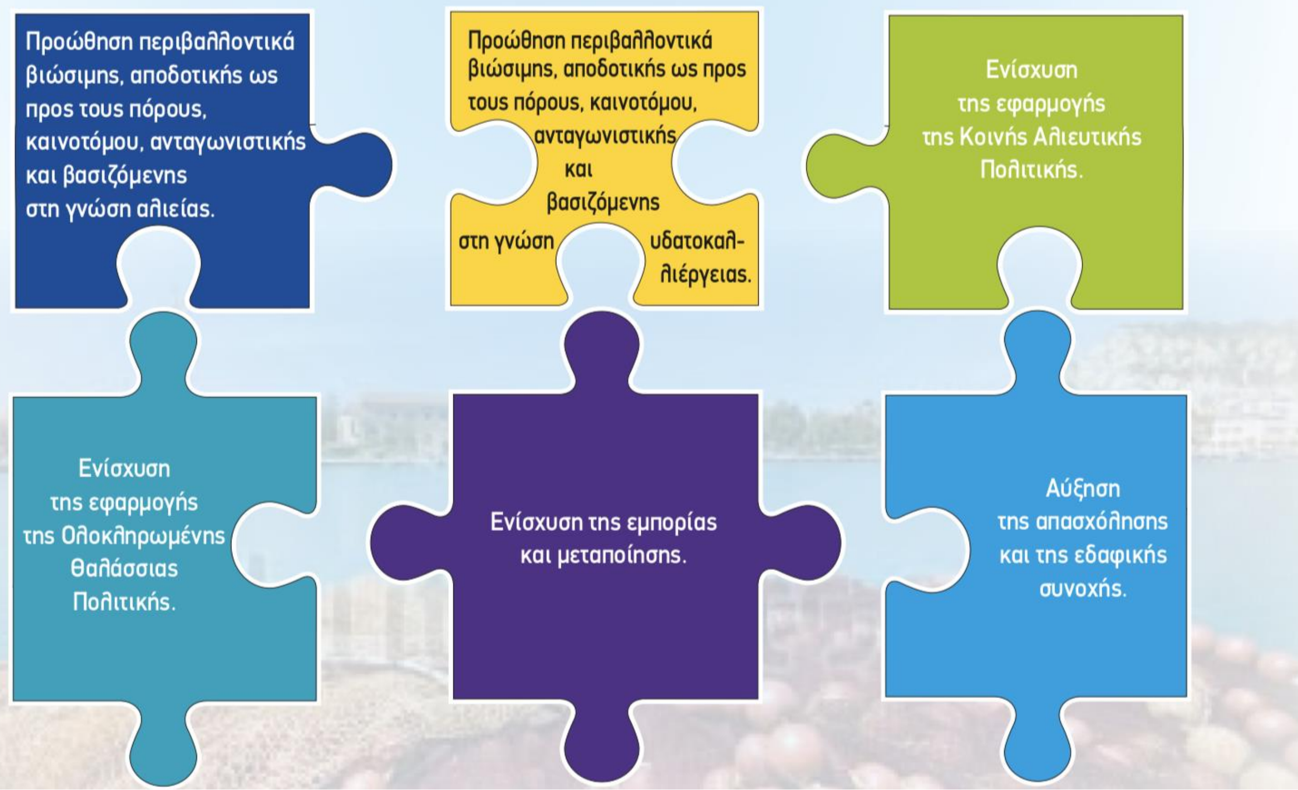
Blue Economy Pilars

Table 2.3 The Established Blue Economy sectors and their subsectors

Sector	Sub-sector
Marine living resources	Primary production
	Processing of fish products
	Distribution of fish products
Marine non-living resources	Oil and gas
	Other minerals
Marine renewable energy	Offshore wind energy
Port activities	Cargo and warehousing
	Port and water projects
Shipbuilding and repair	Shipbuilding
	Equipment and machinery
Maritime transport	Passenger transport
	Freight transport
	Services for transport
Coastal tourism	Accommodation
	Transport
	Other expenditure

Ερευνητικα Εργα ΕΠΑλΘ

Η δομή του ΕΠΑλΘ 2014-2020 αναπροσαρμόζεται γύρω από τις έξι βασικές προτεραιότητες της Ένωσης για την ανάπτυξη της αλιείας, έναντι των πέντε αξόνων της παρούσας προγραμματικής περιόδου, γεγονός που συνεπάγεται αύξηση της συγκέντρωσης των εθνικών και κοινοτικών πόρων γύρω από προτεραιότητες που ανταποκρίνονται σε συγκεκριμένες προκλήσεις και προβλήματα. Οι έξι ενωσιακές προτεραιότητες για την ανάπτυξη της αλιείας είναι οι ακόλουθες:



ΠΡΟΣΚΛΗΣΗ

ΓΙΑ ΤΗΝ ΥΠΟΒΟΛΗ ΠΡΟΤΑΣΕΩΝ
ΣΤΟ ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΑΛΙΕΙΑΣ ΚΑΙ ΘΑΛΑΣΣΑΣ
ΕΝΩΣΙΑΚΗ ΠΡΟΤΕΡΑΙΟΤΗΤΑ 2

Η ΟΠΟΙΑ ΣΥΓΧΡΗΜΑΤΟΔΟΤΕΙΤΑΙ ΑΠΟ ΤΟ ΕΤΘΑ
ΜΕ ΤΙΤΛΟ «**ΚΑΙΝΟΤΟΜΙΑ ΣΤΗΝ ΥΔΑΤΟΚΑΛΛΙΕΡΓΕΙΑ**»

Αθήνα Α.Π.:
10 / 08 / 2017 1214
Κωδικός Πρόσκλησης: Αρ. 47.01
Έκδοση: 1/0
Α/Α ΟΠΣ: 2302

Πρόγραμμα SlurryFish με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

ΚΩΔ. ΟΠΣ/MIS 5010939

“Μελέτη και εφαρμογή καινοτόμων μεθόδων στα στάδια της αλίευσης και της επεξεργασίας για τη βελτίωση της ποιότητας και της διατηρησιμότητας των ιχθυηρών”

Slurry Fish

ΦΟΡΕΙΣ ΤΟΥ ΕΡΓΟΥ

ΠΡΟΫΠΟΛΟΓΙΣΜΟΣ	€ 524.359,05
Ημερομηνία έναρξης	13.06.2018
Ημερομηνία λήξης	31.05.2022

Εθνικό Μετσόβιο Πολυτεχνείο

Εργαστήριο Χημείας και Τεχνολογίας Τροφίμων
Σχολή Χημικών Μηχανικών

Δρ. Ταούκης Πέτρος
Καθηγητής ΕΜΠ (Συντονιστής)
Δρ. Δερμεσονλούογλου Ευφημία
Χημικός Μηχανικός, PhD, Ε.ΔΙ.Π.
Δρ. Θεοφανία Τσιρώνη
Χημικός Μηχανικός, MPH, PhD, Επ. Καθηγήτρια ΓΠΑ
Δρ. Αθηνά Ντζιμάνη
Χημικός MSc, PhD
Ναταλία Σταυροπούλου
Υπ. Διδάκτωρ
Ι.Σεμένογλου
Υπ. Διδάκτωρ

Πανεπιστήμιο Θεσσαλίας

Εργαστήριο Γενετικής, Συγκριτικής και Εξελικτικής Βιολογίας
Τμήμα Βιοχημείας & Βιοτεχνολογίας

Δρ. Αικατερίνη Μούτου
Αναπληρώτρια Καθηγήτρια ΠΘ (Επιστημ. Υπεύθυνη)
Δρ. Ζήσης Μαμούρης
Καθηγητής ΠΘ
Δρ. Κωνσταντίνος Σταμάτης
Πτυχιούχος Φυτικής & Ζωικής Παραγωγής, PhD, Ε.ΔΙ.Π.
Ραφαήλ Αγγελακόπουλος
Υπ. Διδάκτωρ

Philosofish AE

Νίκος Λυμπέρης
Βιολόγος, MSc, Διευθύνων Σύμβουλος
Ξυδιά Δήμητρα
Επόπτης Δημόσιας Υγείας/ Υγιεινολόγος, Υπεύθυνη Διασφάλισης Ποιότητας και Ποιοτικού ελέγχου
Μάρκος Κολυγάς
Ιχθυολόγος, MSc, PhD
Π. Μπιτσάκος
Α. Μασιάλας
Ε. Αυγουστάτος
Χ. Τσιναρόγλου
Ι. Σαρακιώτης
Γ. Ποταμιάς
Δ. Δεδελούδης
Π. Μαρούλης

ΑΝΤΙΚΕΙΜΕΝΟ ΤΟΥ ΕΡΓΟΥ- ΠΡΟΚΛΗΣΕΙΣ

1. Αποτελεσματικότερη **διαχείριση της θερμοκρασίας** κατά την **αλίευση**, τη **μεταφορά** και την **αποθήκευση** των ιχθυηρών
2. **Ελάττωση του αρχικού μικροβιακού φορτίου** των ιχθυηρών και των προϊόντων τους
3. **Γενετική επιλογή** για μείωση των ενδογενών παραγόντων υποβάθμισης της φρεσκάδας

↓

Επιβράδυνση των βιοχημικών και μικροβιολογικών δράσεων που κινητοποιούνται με την αλίευση και ευθύνονται για τη σταδιακή υποβάθμιση της ποιότητας του προϊόντος

ΑΝΤΙΚΕΙΜΕΝΟ ΤΟΥ ΕΡΓΟΥ

Αντικείμενο του προτεινόμενου έργου είναι η ανάπτυξη και εφαρμογή νέων, βελτιωμένων παρεμβάσεων στο στάδιο της αλίευσης και επεξεργασίας ιχθυηρών, με απώτερο στόχο τη βελτίωση της ποιότητας του τελικού προϊόντος και την επέκταση της διατηρησιμότητάς του.

Επιμέρους στόχοι του έργου είναι:

1. η **ανάπτυξη και εφαρμογή εναλλακτικών πρωτοκόλλων κατά την αλίευση** και η μελέτη της επίδρασής τους στην ποιότητα και τη διατηρησιμότητα των ιχθύων, και
2. η **μελέτη και εφαρμογή ενός σταδίου εξυγίανσης του νερού** που χρησιμοποιείται για το πλύσιμο των ιχθύων για τη βελτίωση της ποιότητας και την επέκταση της διατηρησιμότητάς τους
3. η μελέτη της επίδρασης όλων των παραπάνω παρεμβάσεων στους βιοχημικούς μηχανισμούς που καθορίζουν την ποιότητα του φρέσκου προϊόντος μετά την αλίευση
4. ο **προσδιορισμός της γενετικής βάσης της φρεσκότητας** και της αλληλεπίδρασής της με τις μεθόδους εξαλίευσης

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Θάλασσας και Αλιείας
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Υπουργείο Αγροτικής Ανάπτυξης και Τροφίμων
Ε.Π. ΑΛΙΕΙΑΣ ΚΑΙ ΘΑΛΑΣΣΑΣ 2014 - 2020
ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη
Slurry Fish
ΟΠΣ 5010939

ΚΑΙΝΟΤΟΜΙΑ ΤΟΥ ΕΡΓΟΥ ΚΑΙ ΣΥΝΔΕΣΗ ΜΕ ΤΟ ΠΕΡΙΕΧΟΜΕΝΟ ΤΗΣ ΠΡΟΣΚΛΗΣΗΣ

- Εφαρμοσμένη χρήση της γνώσης με σκοπό την ανάπτυξη και βελτίωση εναλλακτικών χειρισμών και πρωτοκόλλων κατά την αλίευση των ιχθύων για την παραγωγή προϊόντων με βελτιωμένη ποιότητα και διατηρησιμότητα (ΠΕ1).
- Αξιοποίηση νέας και υφιστάμενης γνώσης από τους τομείς της τεχνολογίας και επεξεργασίας τροφίμων για τη μετατροπή της ιδέας σε προϊόντα υδατοκαλλιέργειας (ΠΕ2).
- Για πρώτη φορά επιχειρείται μια συνδυαστική προσέγγιση που λαμβάνει υπόψη τόσο τεχνολογικές λύσεις όσο και τα στοιχεία της βιολογίας των ψαριών που έχουν γνωστή και σημαντική επίδραση στη ποιότητα του φρέσκου προϊόντος (ΠΕ3 και ΠΕ4).
- Οι στόχοι και τα αποτελέσματα του έργου αναφέρονται σε βιώσιμες καινοτόμες μεθόδους παραγωγής και περιορίζουν την επίπτωση στο περιβάλλον (επέκταση διατηρησιμότητας → ελάττωση απωλειών).
- Τα αποτελέσματα του έργου υπόκεινται σε κατάλληλη δημοσιότητα (ΠΕ5).

ΜΕΘΟΔΟΛΟΓΙΑ ΥΛΟΠΟΙΗΣΗΣ ΤΟΥ ΕΡΓΟΥ

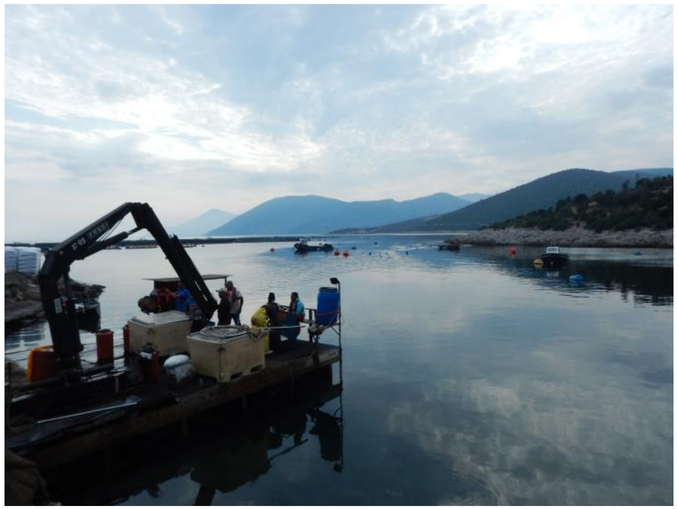
Ανάπτυξη και εφαρμογή εναλλακτικών μεθόδων ψύξης των ιχθύων κατά την αλίευση

Υγρός πάγος (slurry ice) → μείγμα νερού-πάγου που επιτρέπει τη θερμοκρασία να διατηρείται σε θερμοκρασίες χαμηλότερες των 0°C.

Διφασικό σύστημα: αποτελείται από μικρά σφαιρικά κομμάτια πάγου (διαμέτρου **0.1-1 mm)** τα οποία περιβάλλονται από θαλασσινό νερό σε θερμοκρασίες < 0°C.

ΜΕΘΟΔΟΛΟΓΙΑ ΥΛΟΠΟΙΗΣΗΣ ΤΟΥ ΕΡΓΟΥ

Εγκατάσταση εξοπλισμού παραγωγής υγρού πάγου στην εταιρία Philosofish (Λάρυμνα)

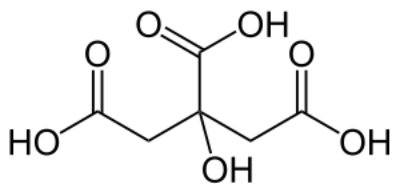


ΜΕΘΟΔΟΛΟΓΙΑ ΥΛΟΠΟΙΗΣΗΣ ΤΟΥ ΕΡΓΟΥ

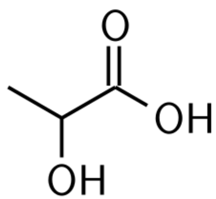
Ανάπτυξη και εφαρμογή νέων μεθόδων για την εξυγίανση του νερού για χρήση κατά την επεξεργασία των ιχθύων

Τα οργανικά οξέα τα οποία χρησιμοποιήθηκαν ήταν:

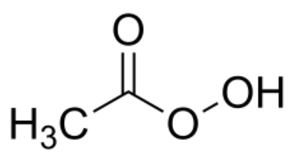
- Κιτρικό οξύ



- Γαλακτικό οξύ

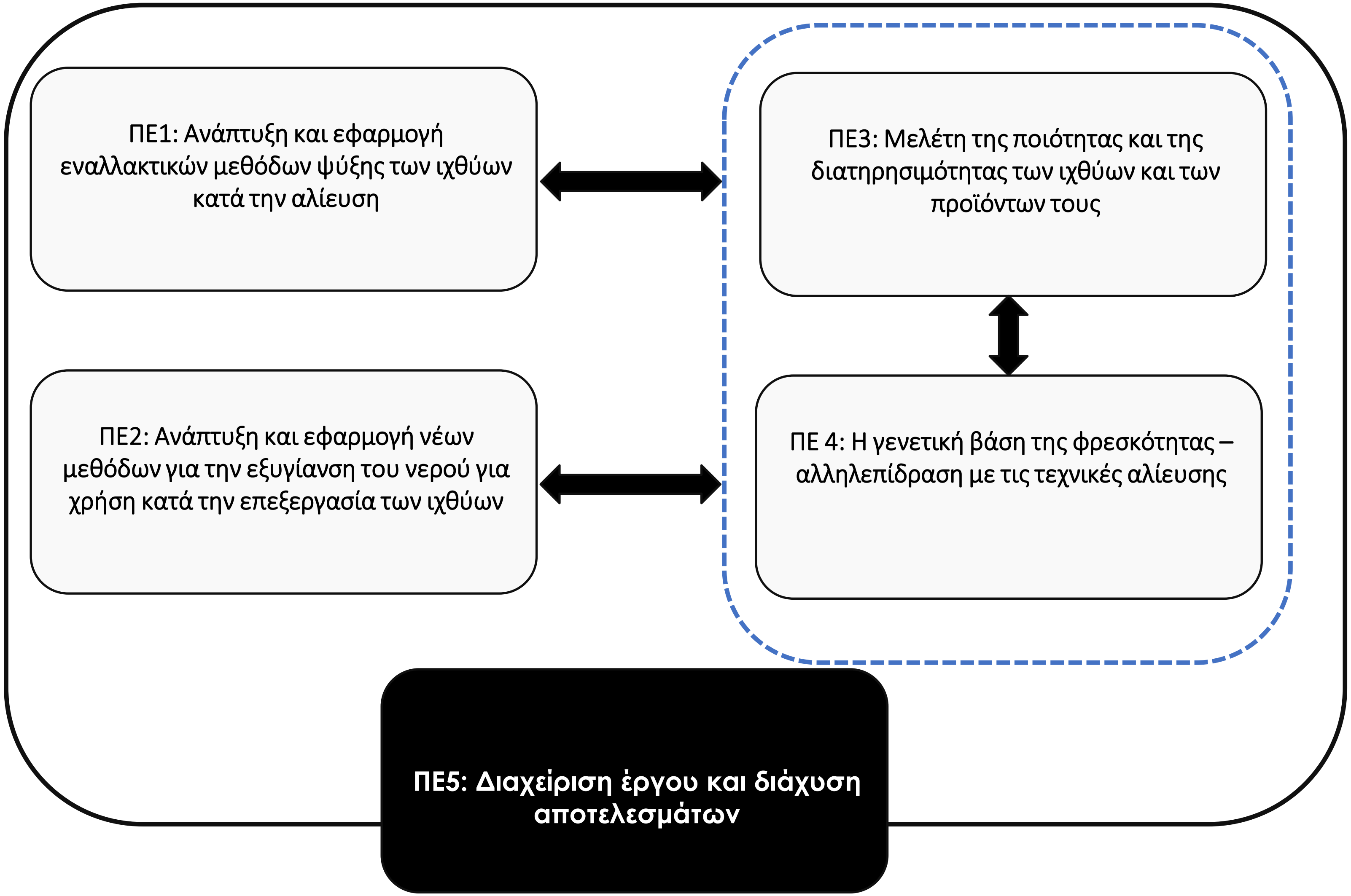


- Υπεροξικό οξύ (PAA, Peracetic acid)



Επιφανειακή εξυγίανση → Ελάττωση αρχικού μικροβιακού φορτίου

ΜΕΘΟΔΟΛΟΓΙΑ ΥΛΟΠΟΙΗΣΗΣ ΤΟΥ ΕΡΓΟΥ



ΑΠΟΤΕΛΕΣΜΑΤΑ – ΑΜΟΙΒΑΙΑ ΟΦΕΛΗ

Η εφαρμογή των νέων και βελτιστοποιημένων μεθόδων επέτρεψε:

- Βελτίωση της ποιότητας των προϊόντων ιχθυηρών → παραγωγή προϊόντων ανώτερης ποιότητας με βελτιστοποιημένα φυσικοχημικά και οργανοληπτικά χαρακτηριστικά
- Επέκταση της διάρκειας ζωής των προϊόντων → ελάττωση απωλειών και συνολικού κόστους παραγωγής
- Εκτίμηση της επίδρασης των περιβαλλοντικών συνθηκών (εποχικότητα) στην αρχική ποιότητα και τη διατηρησιμότητα

- Ανάπτυξη μαθηματικών μοντέλων πρόβλεψης της ποιοτικής υποβάθμισης των ιχθύων και των προϊόντων τους κατά τη συντήρηση → βασικά εργαλεία για το σχεδιασμό και τη βελτιστοποίηση των συνθηκών αλίευσης και μεταποίησής τους

Διάχυση αποτελεσμάτων (άρθρα σε έγκριτα διεθνή επιστημονικά περιοδικά)

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Aquaculture and Fisheries xxx (xxxx) xxx

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Slurry ice as an alternative cooling medium for fish harvesting and transportation: Study of the effect on seabass flesh quality and shelf life

Athina Ntzimani [1], Rafael Angelakopoulos [2], Ioanna Semenoglou [1], Efimia Dermesonlouoglou [1], Theofania Tsironi [1,3,*], Katerina Moutou [2], Petros Taoukis [1]

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foods

MDPI

Article

Seasonal pattern of the effect of slurry ice during harvesting and transportation on fish quality and shelf life

Athina Ntzimani [1], Rafael Angelakopoulos [2], Natalia Stavropoulou [1], Ioanna Semenoglou [1], Efimia Dermesonlouoglou [1], Theofania Tsironi [1,3*], Katerina Moutou [2] and Petros Taoukis [1]

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sustainability

MDPI

Article

Surface Decontamination and Shelf-Life Extension of Gilthead Sea Bream by Alternative Washing Treatments

Athina Ntzimani [1], Ioanna Semenoglou [1], Efimia Dermesonlouoglou [1], Theofania Tsironi [1,2] and Petros Taoukis [1,*]

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Διάχυση αποτελεσμάτων (παρουσιάσεις σε επιστημονικά συνέδρια)

Tsironi T., Semenoglou I., Ntzimani A., Dimopoulos G., Taoukis P. Nonthermal and minimal processing of fresh Mediterranean marine cultured fish for quality improvement and shelf life extension. IFT Annual Meeting and Food Expo, New Orleans, LA, USA, 2-5 June 2019 (poster presentation).

Nonthermal and minimal processing of fresh Mediterranean marine cultured fish for quality improvement and shelf life extension

Theofania Tsironi, Ioanna Semenoglou, Athina Ntzimani, George Dimopoulos, Petros Taoukis

School of Chemical Engineering, National Technical University of Athens, Greece (taoukis@chemeng.ntua.gr)

Introduction

The short shelf life and perishability of fish products is a commercial drawback and methods of extension are being investigated. New non-thermal food processing methods are sought by the industry in the pursuit of producing better quality foods with extended shelf life. The advantages of nonthermal processing over classical thermal methods include the better retention of nutritional and sensory properties (Tsironi et al., 2014 and 2019). Several studies have been conducted recently on the efficacy of washing and sanitizing treatments in reducing microbial populations on food products. Limited work on the effect of nonthermal and minimal treatments on fish has been published and no industrial scaling-up has been reported (Fidalgo et al., 2011). The objective of the study was to investigate the effect of nonthermal i.e. high pressure (HP), osmotic dehydration (OD), pulsed electric fields (PEF) and minimal processing methods (i.e. surface decontamination of fish) on the quality and shelf life of farmed gilthead seabream and European sea bass during refrigerated storage.

Materials & Methods

Gilthead seabream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*) fillets were treated using HP (600 MPa, 5 min, 25°C - FPU 1.01, Resato International BV, Roden, Holland), OD (40-60% glycerol, 5% NaCl, 15°C, 0-240 min) and PEF (250-1000 pulses , 15 μs, 20 Hz, 1,7 kV/cm- Elcrack-5kW, DIL, Quakenbruck, Germany) as alternative approaches to the conventional post-harvest fish processing methods. The incorporation of natural organic acids (0-200 ppm, 0-10 min - lactic acid, citric acid) at different concentrations in the washing water during gutting was also tested for its efficacy to reduce initial microbial load and prolong shelf life. Samples were stored under controlled isothermal conditions (0-10°C). Quality assessment was based on microbiological analysis (total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp.), pH, colour , texture measurement and sensory scoring. A sensory score of 5 was taken as the average score for minimum acceptability. Temperature in the incubators was constantly monitored with electronic, programmable miniature data-loggers (COX TRACER ®, Belmont, NC).

Results

Effect of HP processing on fish

HP resulted in more than a 5 logcfu/g reduction in the initial TVC. *Pseudomonas* (reported food spoilers) persisted in HP fillets. The shelf life of the untreated samples was 10 days and for the HP-treated fillets exceeded 2 months (based on a minimum score of 5 for overall acceptability scoring in a 1 to 9 hedonic sensory scale). However, it affected significantly the texture and colour of the fish flesh (Picture 1, Figure 1).

Picture 1. HP (600 MPa, 5 min, 25°C) treated sea bass fillets after 67 days of isothermal storage at 2°C.

Figure 1. Sensory profile of untreated (Control) and HP (600 MPa, 5 min, 25°C) treated sea bass fillets during isothermal storage at 2°C.

Effect of OD treatment on fish

Osmotic dehydration caused substantial a_w decrease with higher solution concentrations showing the strongest effect. A_w was initially 0.99 and reached final values between 0.87, 0.83 and 0.82 after 240 min of osmotic treatment at 40, 50 and 60% glycerol, respectively. The effective diffusion coefficients of water (D_{ew}) and solids (D_{es}) were calculated by applying Fick's law on the experimental data (Table 1).

Table 1. Effective diffusion coefficients of water (D_{ew}) and solids (D_{es}) during osmotic dehydration of sea bass fillets,

Treatment	D_{ew} ($m^2 \cdot s^{-1}$)	D_{es} ($m^2 \cdot s^{-1}$)
40% glycerol	1,90 (± 0,15) ·10[illegible]	1,82 (± 0,12) ·10[illegible]
50% glycerol	2,77 (± 0,15) ·10[illegible]	2,50 (± 0,21) ·10[illegible]
60% glycerol	3,62 (± 0,27) ·10[illegible]	4,12 (± 0,55) ·10[illegible]
PEF/50% glycerol	4,03 (± 0,32) ·10[illegible]	4,14 (± 0,38) ·10[illegible]

OD resulted in significant shelf life extension of fish fillets (6 days and up to 10 days for untreated and osmo-treated samples at 5°C, respectively).

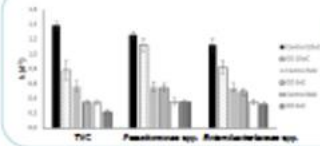

Figure 2. Microbial growth rates in OD (50% glycerol, 30 min) treated sea bass fillets during isothermal storage at 0-10°C.

Combined effect of OD and PEF on fish

PEF enhanced the mass transfer phenomena during osmotic treatment but did not affect significantly the quality and shelf life of fish fillets. PEF pretreatment further increased D_{ew} and D_{es} values up to 50% and 66% respectively (for 1500 pulses) and the number of pulses correlated with the calculated D_{ew} and D_{es} values, following a logistic mathematical model.

Effect of washing with organic acids on fish

Initial surface decontamination (up to 2 logcfu/g for total viable count, *Pseudomonas* spp. and *Enterobacteriaceae* spp.) by the addition of organic acids in the washing water was observed, which may result in 2-4 days shelf life extension of fish fillets at 0°C.

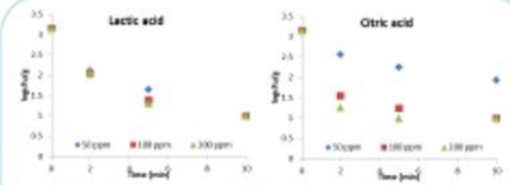

Figure 3. *Enterobacteriaceae* spp. load in whole gilthead seabream after washing during gutting with lactic acid or citric acid at concentrations 0-200 ppm and 0-10 min.

Conclusions

The results of the study indicated that the application of nonthermal and minimal processing led to improved quality stability during subsequent refrigerated storage and significant shelf life extension, in terms of microbial growth, physicochemical and organoleptic degradation of the fillets. Minimal processing of fish could open new distant markets currently inaccessible to fresh fish products and allow the use of higher temperatures (5°C) in the cold chain of seafood which would significantly reduce energy and food waste.

References

• Fidalgo, L.G., Saraiva, J.A., Aubourg, S.P., Vazquez, M., Torres, J.A. (2011). Czech Journal of Food Sciences, 32(2), 188-193. • Tsironi, T., Maltezou, I., Tsevdou, M., Katsaros, G., Taoukis, P. (2014). Food and Bioprocess Technology, 8 (3), pp. 581-590. • Tsironi T., Anjos L., Pinto P.I.S., Dimopoulos G., Santos S., Santa C., Manadas B., Canario A., Taoukis P., Power D. (2019). Journal of Food Engineering, 262, pp. 83-91.

Acknowledgment

The research was partly funded by the Operational Programme for Fisheries and Maritime 2014-2020-Greece, Priority 2, Measure 3.2.1, Article 47. (MIS 5019170 for the evaluation of the effect of HP processing on fish fillets and MIS 5010939 for the development and application of surface sanitization methodologies on whole fish)

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Tsironi T., Semenoglou I., Ntzimani A., Dimopoulos G., Tsevdou M., Taoukis P. Comparative study of the effect of novel treatments on quality and shelf life of cultured seabass and seabream. 2nd Innovations in Food Science and Technology: An International Conference, Amsterdam, Netherlands, 25-27 June 2019 (oral presentation).

PROGRAMME

TUESDAY, 25 JUNE 2019	
12:30 -13:00	Registration/Welcome Reception
12:30 -16:00	Registration continued......
13:00 - 13:10	Conference Opening
13:10-13:40	Keynote-1. Surface finish of stainless steel and cleanability Wouter Burgraaf, European Hygienic Engineering and Design Group, Netherlands
13:40-14:10	Keynote-2. Sustainabilty of food packaging Prof. H.C. Langowski, Technical University of Munich, Germany
14:10-14:35	Keynote-3. Debunking misinformation about food Huub Lelieveld, Veslemøy Andersen: Global Harmonization Initiative
14:35-15:00	Keynote-4. The search for new protein sources for plant-based meat alternatives Atze Jan Van Der Goot, Food Process Engineering Laboratory, Wageningen University & Research, The Netherlands
15:00 - 15:30	Coffee/Tea Break
THEME: FOOD PROCESS ENGINEERING	
Room	Panaroma Room
Chair Co-Chair	Atze Jan Van Der Goot, Wageningen University, Netherlands H.C. Langowski, Technical University of Munich, Germany
15:30-15:55	INV 1: Dry food processing for sustainable production of high-quality foods Maarten Schutyser*, Food Process Engineering Laboratory, Wageningen University & Research, The Netherlands
15:55-16:20	INV 2: The role of polyphenols in novel biorefinery processing Konstantina Kyriakopoulou*, Food Process Engineering Laboratory, Wageningen University & Research, The Netherlands
16:20-16:40	Title: Food waste recovery & innovation Charis Galanakis*, Food Waste Recovery Group, ISEKI Food Association, Vienna, Austria
16:40-17:00	Title: Increasing the local effectiveness of aerosol application by selective flow field Modifications Yvonne Ringelspacher*, A. Delgado, Institute of Fluid Mechanics, Friedrich-Alexander-University Erlangen-Nürnberg, Germany
17:00-17:20	Title: Biorefinery residues for food packaging applications Marisa Costa Gaspar*, Cátia Mendes, Maria da Graça Carvalho, Mara Elga Medeiros Braga, University of Coimbra, Coimbra, Portugal

WEDNESDAY, 26 JUNE 2019	
Session	Innovative Processing Technologies
Chair Co-Chair	Petros Taoukis, National Technical University of Athens, Greece Huub Lelieveld, Global Harmonization Initiative
09:00-09:25	INV 3: Comparative study of the effect of novel treatments on quality and shelf life of cultured seabass and seabream. Theofania Tsiron, Ioanna Semenoglou, Athina Ntzimani, George Dimopoulos, Maria Tsevdou, Petros Taoukis* National Technical University of Athens, Greece
09:25-09:50	Title: Local Adaptive Drying by means of Nozzles Bastian Schoeneberger*, Antonio Delgado, Institute of Fluid Mechanics, Friedrich-Alexander-University Erlangen-Nürnberg, Germany
09:50-10:10	Title: Development of an inline sensor for the analysis of process-relevant properties during bakery production using Dynamic Laser Speckle Imaging Stefan Steinhauser*, Ehsan Fattahi Evati, Dominik Geier, Thomas Becker Chair of Brewing and Beverage Technology, Technical University of Munich, Freising, Germany
10:10-10:30	Title: Inline monitoring of fermentation activity during beer production with ultrasound Michael Metzenmacher*, Dominik Geier, Thomas Becker Chair of Brewing and Beverage Technology, Technical University of Munich, Freising, Germany
10:30-11:00	Tea/Coffee break/Poster Session
11:00-11:20	Title: Supercritical carbon dioxide extraction of oil from Andean lupin seeds Miao Yu*, Kai Kniepkamp, Juliette Rudzick, Jan Pieter Thie, Geert-Jan Witkamp, Rob van Haren Hanze University of Applied Sciences, Groningen, Netherlands
11:20-11:40	Title: Are bacterial spores activated by High Pressure treatment at 20°C ? Hélène Simonin*, Chloé Modugnoi, Jean-Marie Perrier-Cornet Univ. Bourgogne Franche-Comté, AgroSup Dijon, PAM UMR A 02.102, Dijon, France

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Θάλασσας και Αλιείας
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Υπουργείο Αγροτικής Ανάπτυξης και Τροφίμων
Ε.Π. ΑΛΙΕΙΑΣ ΚΑΙ ΘΑΛΑΣΣΑΣ 2014 - 2020
ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη
Slurry Fish
ΟΠΣ 5010939

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Tsironi T., Semenoglou I., Ntzimani A., Dermesonlouoglou E., Taoukis P. “Modeling the effect of surface washing treatment on inactivation of spoilage bacteria and shelf life extension of fresh fish”. ICEF13 International Congress on Engineering and Food. Melbourne, Australia, 23-26 September 2019 (Poster presentation and mini-oral).

Modeling the effect of surface washing treatment on inactivation of spoilage bacteria and shelf life extension of fresh fish

ICEF13

Theofania Tsironi, Ioanna Semenoglou, Athina Ntzimani, Efimia Dermesonlouoglou, Petros Taoukis

School of Chemical Engineering, National Technical University of Athens, Greece (*taoukis@chemeng.ntua.gr*)

Introduction

The short shelf life and perishability of fish products is a commercial drawback and methods of extension are being investigated. New minimal and nonthermal food processing methods are sought by the industry in the pursuit of producing better quality fish products with extended shelf life with retention of nutritional and sensory properties (Tsironi et al., 2014 and 2019; Tsironi and Taoukis, 2019). Several studies have been conducted recently on the efficacy of washing and sanitizing treatments in reducing microbial populations on food products. Limited work on the effect on fish has been published and no industrial scaling-up has been reported (Thi et al., 2015).

The objective of the study was to investigate and mathematically model the effect of surface decontamination of fresh fish using alternative organic acids on the quality and shelf life during refrigerated storage.

Materials & Methods

Marine cultured gilthead seabream (*Sparus aurata*) were stored isothermally at 0°C for 6 days after harvesting. Fish was gutted manually and immersed in water for 0-10 min. The incorporation of natural organic acids (lactic acid, citric acid) at different concentrations (0-200 ppm) for times 0-10 min during gutting was tested for its efficacy to reduce initial microbial load and prolong shelf life.

Control (treated with water) and organic acid treated samples were afterwards stored under controlled isothermal conditions (0-10°C) for shelf life testing. Quality assessment was based on microbiological analysis (total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp., lactic acid bacteria, H_2S-producing bacteria, etc), pH, colour, texture measurement and sensory scoring. A sensory score of 5 was taken as the average score for minimum acceptability.

Results

Initial surface decontamination (up to 2 logcfu/g for total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp. and H_2S-producing bacteria, depending on species and processing conditions) by the addition of organic acids in the washing water was observed (Figures 1 a-c).

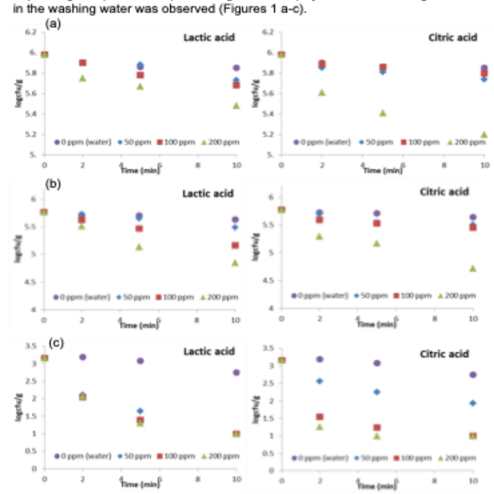

Figure 1. Results after washing with lactic acid or citric acid at concentrations 0-200 ppm for 0-10 min on (a) Total viable count, (b) *Pseudomonas* spp. and (c) *Enterobacteriaceae*, in whole gilthead seabream.

Microbial load reduction was increased for higher washing solution concentrations and longer treatment. Higher reduction of the initial microbial load was observed after treatment with citric acid for TVC, *Pseudomonas* spp. and H_2S-producing bacteria and with lactic acid solution for *Enterobacteriaceae* spp.

Mathematical models were developed for the inactivation of spoilage bacteria as a function of treatment conditions and the concentration of acid in the washing water. The experimental data were adequately described by Equation (1):

$$\log\left(\frac{N}{N_O}\right) = a * \sqrt{C-b} * e^{-d*t} \quad (1)$$

where N_o and N are the initial and final (after treatment) microbial load, C is % (w/v) washing solution concentration, t is treatment (min) and a, b, d are constants.

Microbial growth during subsequent refrigerated storage of untreated (Control) and treated fish was modeled using the Baranyi Growth Model. Limit of sensory shelf life of gutted fish (score 5 by the sensory panel for overall impression) coincided with a *Pseudomonas* spp. level of 10^7 cfu/g at all tested storage temperatures (0-10°C). Based on the values at the end of the shelf life of the studied indices and the temperature dependence of their rate constants expressed by the Arrhenius kinetics, simple equations for shelf life calculation can be used (Equation 2).

$$t_{SL} = \frac{logN_l - logN_o}{k_{ref} \cdot exp\left[\frac{-E_a}{R}\cdot\left(\frac{1}{T}-\frac{1}{T_{ref}}\right)\right]} \quad (2)$$

where t_{SL} is the shelf life (d) of gilthead seabream, $logN_l$ is the limit *Pseudomonas* spp. load (7 log cfu/g), *logNo* is the initial *Pseudomonas* spp. load, k_{ref} is the rate constant of *Pseudomonas* spp. growth at a reference temperature T_{ref} (4°C), E_a is the activation energy of *Pseudomonas* spp. growth, R is the universal gas constant.

Based on these calculations, the shelf life of gutted gilthead seabream for different treatment conditions is presented in Table 1.

Table 1. Shelf life (days) of gutted gilthead seabream for different processing and storage conditions.

Processing / storage conditions	Control	Citric acid (100ppm/5 min)	Citric acid (200 ppm/10 min)
0°C	12	13	16
5°C	6	7	8
10°C	4	5	6

Conclusions

The results of the study indicated that the application of washing treatment led to improved quality stability during subsequent refrigerated storage and shelf life extension. Initial surface decontamination up to 2.0 logcfu/g by the addition of organic acids in the washing water may result in 2-4 days shelf life extension of gutted fish at 0°C storage. Shelf life extension of fish could open new distant markets currently inaccessible to fresh fish products and allow the use of higher temperatures (e.g. 5°C) in the cold chain of seafood which would significantly reduce energy and food waste.

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Acknowledgment

The research was funded by the Operational Programme for Fisheries and Maritime 2014-2020-Greece, Priority 2, Measure 3.2.1, Article 47. (MIS 5010939-Development and application of novel methods for fish harvesting and processing for quality improvement and shelf life extension)

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Tsironi T., Semenoglou I., Machairas D., Ntzimani A., Dimopoulos G., Taoukis P. “Quality enhancement and shelf life extension of fresh Mediterannean fish by nonthermal and minimal processing”. Aquaculture Europe 2019, Berlin, Germany, 7-10 October 2019 (Poster presentation).

Quality enhancement and shelf life extension of fresh Mediterranean fish by nonthermal and minimal processing

Tsironi T.*, Semenoglou I., Machairas D., Ntzimani A., Dimopoulos G., Dermesonlouoglou E., Taoukis P.
School of Chemical Engineering, National Technical University of Athens, Greece (*taoukis@chemeng.ntua.gr*)

Introduction

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The objective of the study was to investigate the effect of nonthermal, i.e. osmotic dehydration (OD), pulsed electric fields (PEF) and minimal processing (i.e. surface decontamination) on the quality and shelf life of farmed gilthead seabream and European sea bass during refrigerated storage.

Materials & Methods

Gilthead seabream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*) fillets were treated using, OD (glycerol/NaCl solutions) and PEF (250-1000 pulses , 15 μs, 20 Hz, 1,7 kV/cm- Elcrack-5kW, DIL, Quakenbruck, Germany) as alternative approaches to the conventional post-harvest fish processing methods. The incorporation of natural organic acids (0-200 ppm, 0-10 min-lactic acid or citric acid, 0-150 ppm, 0-4 min-peracetic acid) at different concentrations in the washing water during gutting was also tested for its efficacy to reduce initial microbial load and prolong shelf life. Samples were stored under controlled isothermal conditions (0-10°C). Quality assessment was based on microbiological analysis (total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp.), pH, colour , texture measurement and sensory scoring. A sensory score of 5 was taken as the average score for minimum acceptability. Temperature in the incubators was constantly monitored with electronic, programmable miniature data-loggers (COX TRACER ®, Belmont, NC).

Results

Effect of washing with organic acids on fish

Initial surface decontamination (up to 2 logcfu/g for total viable count, *Pseudomonas* spp. and *Enterobacteriaceae* spp.) by the addition of organic acids in the washing water was observed (Figure 1). Microbial load reduction was increased for higher washing solution concentrations and longer treatment. Higher reduction of the initial microbial load was observed after treatment with citric acid for TVC, *Pseudomonas* spp. and H_2S-producing bacteria and with lactic acid solution for *Enterobacteriaceae* spp.

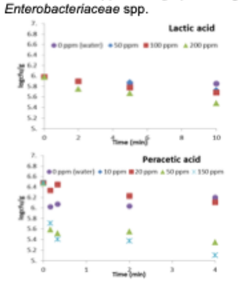

Figure 1. Total viable count (logcfug) in whole gilthead seabream (*Sparus aurata*) after surface washing with lactic acid, citric acid or peracetic acid.

Mathematical models were developed for the inactivation of spoilage bacteria as a function of treatment conditions and the concentration of acid in the washing water. The experimental data were adequately described by Equation (1):

$$\log\left(\frac{N}{N_O}\right) = a * \sqrt{C - b} * e^{-d*t}$$

where N_o and N are the initial and final (after treatment) microbial load, C is % (w/v) washing solution concentration, t is treatment (min) and a, b, d are constants. Limit of sensory shelf life of gutted fish (score 5 by the sensory panel for overall impression) coincided with a *Pseudomonas* spp. level of 10^7 cfu/g at all tested storage temperatures (0-10°C). The shelf life of gutted gilthead seabream for different treatment conditions is presented in Table 1.

Table 1. Shelf life (days) of gutted gilthead seabream for different processing and storage conditions

Processing / storage conditions	Control	Citric acid (100ppm/5 min)	Citric acid (200 ppm/10 min)
0°C	12	13	16
5°C	6	7	8
10°C	4	5	6

Effect of OD treatment on fish

Osmotic dehydration caused substantial a_w decrease with higher solution concentrations showing the strongest effect. A_w was initially 0.99 and reached final values between 0.87, 0.83 and 0.82 after 240 min of osmotic treatment at 40, 50 and 60% glycerol, respectively. The effective diffusion coefficients of water (D_{ew}) and solids (D_{es}) were calculated by applying Fick's law on the experimental data (Table 1).

Table 1. Effective diffusion coefficients of water (D_{ew}) and solids (D_{es}) during osmotic dehydration of sea bass fillets

Treatment	D_{ew} ($m^2 \cdot s^{-1}$)	D_{es} ($m^2 \cdot s^{-1}$)
40% glycerol	1,90 (± 0,15) $\cdot 10^{-9}$	1,82 (± 0,12) $\cdot 10^{-9}$
50% glycerol	2,77 (± 0,15) $\cdot 10^{-9}$	2,50 (± 0,21) $\cdot 10^{-9}$
60% glycerol	3,62 (± 0,27) $\cdot 10^{-9}$	4,12 (± 0,55) $\cdot 10^{-9}$
PEF/50% glycerol	4,03 (± 0,32) $\cdot 10^{-9}$	4,14 (± 0,38) $\cdot 10^{-9}$

OD resulted in significant shelf life extension of fish fillets (6 days and up to 10 days for untreated and osmo-treated samples at 5°C, respectively).

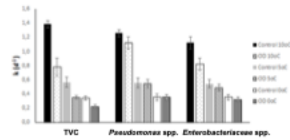

Figure 2. Microbial growth rates in OD treated sea bass fillets during isothermal storage at 0-10°C.

Combined effect of OD and PEF on fish

PEF enhanced the mass transfer phenomena during osmotic treatment but did not affect significantly the quality and shelf life of fish fillets. PEF pretreatment further increased D_{ew} and D_{es} values up to 50% and 66% respectively (for 1500 pulses) and the number of pulses correlated with the calculated D_{ew} and D_{es} values, following a logistic mathematical model (Table 1).

Conclusions

The results of the study indicated that the application of nonthermal and minimal processing led to improved quality stability during subsequent refrigerated storage and significant shelf life extension, in terms of microbial growth, physicochemical and organoleptic degradation of the fillets. Minimal processing of fish could open new distant markets currently inaccessible to fresh fish products and allow the use of higher temperatures (5°C) in the cold chain of seafood which would significantly reduce energy and food waste. The application of surface sanitization by washing with organic acids proved comparatively effective to the alternative minimal and nonthermal processes studied.

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Acknowledgment

This study was supported by the Greek Operational Programme for Fisheries, Priority Axis "Innovation in Aquaculture", Project title: "Development and application of novel methods at harvesting and processing of fish for quality improvement and shelf life extension" (2018-2021) website: slurryfish.chemeng.ntua.gr

ΕΠΑλΘ 2014-2020
NSRF 2014-2020

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Machairas D., Semenoglou I., Ntzimani A., Tsironi T., Taoukis P. "Mathematical modelling of the fish surface microbial inactivation by alternative washing media". 33rd EFFoST International Conference. Sustainable Food Systems - Performing by Connecting, Rotterdam, The Netherlands, 12-14 November 2019 (Poster presentation).

Mathematical modelling of the fish surface microbial inactivation by alternative washing media

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EFFoST 2019 International Conference

www.effostconference.com

Introduction

The short shelf life and perishability of fish products is a commercial drawback and methods of extension are being investigated. New minimal and nonthermal food processing methods are sought by the industry in the pursuit of producing better quality fish products with extended shelf life with retention of nutritional and sensory properties (Tsironi et al., 2015 and 2019; Tsironi and Taoukis, 2019). Several studies have been conducted recently on the efficacy of washing and sanitizing treatments in reducing microbial populations on food products. Limited work on the effect on fish has been published and no industrial scaling-up has been reported (Thi et al., 2015).

The objective of the study was to investigate and mathematically model the effect of surface decontamination of fresh fish using alternative organic acids on the quality and shelf life during refrigerated storage.

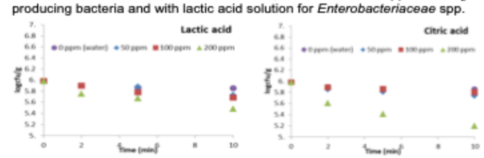
Materials & Methods

Marine cultured gilthead seabream (*Sparus aurata*) were stored isothermally at 0°C for 6 days after harvesting. Fish was gutted manually and immersed in water for 0-10 min. The incorporation of natural organic acids (lactic acid, citric acid, peracetic acid) at different concentrations (0-200 ppm) for times 0-10 min during gutting was tested for its efficacy to reduce initial microbial load and prolong shelf life.

Control (treated with water) and organic acid treated samples were afterwards stored under controlled isothermal conditions (0-10°C) for shelf life testing. Quality assessment was based on microbiological analysis (total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp., lactic acid bacteria, H_2S-producing bacteria, etc), pH, colour, texture measurement and sensory scoring (1-9 scale). A sensory score of 5 was taken as the average score for minimum acceptability.

Results

Initial surface decontamination (up to 2 logcfu/g for total viable count, *Pseudomonas* spp. and *Enterobacteriaceae* spp.) by the addition of organic acids in the washing water was observed (Figure 1). Increased microbial load reduction was achieved for higher washing solution concentrations and longer treatment. Higher reduction of the initial microbial load was observed after treatment with citric acid for TVC, *Pseudomonas* spp. and H_2S-producing bacteria and with lactic acid solution for *Enterobacteriaceae* spp.



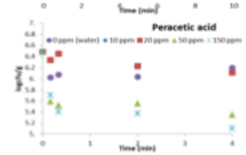


Figure 1. Total viable count (logcfug) in whole gilthead seabream (*Sparus aurata*) after surface washing with lactic acid, citric acid or peracetic acid

Mathematical models were developed for the inactivation of spoilage bacteria as a function of treatment conditions and the concentration of acid in the washing water. The experimental data were adequately described by Equation (1):

$$log\left(\frac{N}{N_o}\right) = \alpha \cdot \sqrt{C+b} \cdot e^{-d \cdot t} \quad (1)$$

where N_o and N are the initial and final (after treatment) microbial load, C is % (w/v) washing solution concentration, t is treatment (min) and α, b, d are constants.

	Lactic acid	Citric acid
a	-0.015	-0.022
b	2.574	2.151
d	-0.137	-0.096

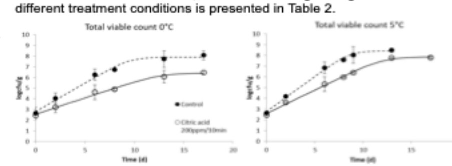
Table 1. Constants of Eq.1 for the inactivation of *Pseudomonas* spp. as a function of washing parameters

Microbial growth during subsequent refrigerated storage of untreated (Control) and treated fish was modeled using the Baranyi Growth Model (Figure 2). Limit of sensory shelf life of gutted fish (score 5 by the sensory panel for overall impression) coincided with a *Pseudomonas* spp. level of 10^7 cfu/g at all tested storage temperatures (0-10°C). Based on the values at the end of the shelf life of the studied indices and the temperature dependence of their rate constants expressed by the Arrhenius kinetics, simple equations for shelf life calculation can be used (Equation 2).

$$t_{SL} = \frac{logN_l - logN_o}{k_{ref} \cdot exp\left[\frac{-E_a}{R} \cdot \left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]} \quad (2)$$

where t_{SL} is the shelf life (d) of gilthead seabream, $logN_l$ is the limit *Pseudomonas* spp. load (7 log cfu/g), $logN_o$ is the initial *Pseudomonas* spp. load, k_{ref} is the rate constant of *Pseudomonas* spp. growth at a reference temperature T_{ref} (4°C), E_a is the activation energy of *Pseudomonas* spp. growth (60-70 kJ/mol for the different treatments), R is the universal gas constant.

Based on these calculations, the shelf life of gutted gilthead seabream for different treatment conditions is presented in Table 2.



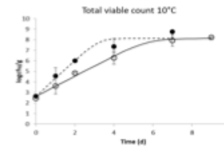


Figure 2. Total viable count (logcfug) in whole gilthead seabream (*Sparus aurata*) after surface washing with citric acid (200ppm for 10min) or water (Control) during isothermal storage at 5°C

Table 2. Shelf life (days) of gutted gilthead seabream for different processing and storage conditions

Processing / storage conditions	Control	Citric acid (100ppm/5 min)	Citric acid (200 ppm/10 min)
0°C	12	13	16
5°C	6	7	8
10°C	4	5	6

Conclusions

The results of the study indicated that the application of washing treatment led to improved quality stability during subsequent refrigerated storage and shelf life extension. Initial surface decontamination up to 2.0 logcfu/g by the addition of organic acids in the washing water may result in 2-4 days shelf life extension of gutted fish at 0°C storage. Shelf life extension of fish could open new distant markets currently inaccessible to fresh fish products and allow the use of higher temperatures (e.g. 5°C) in the cold chain of seafood which would significantly reduce energy and food waste.

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Acknowledgment

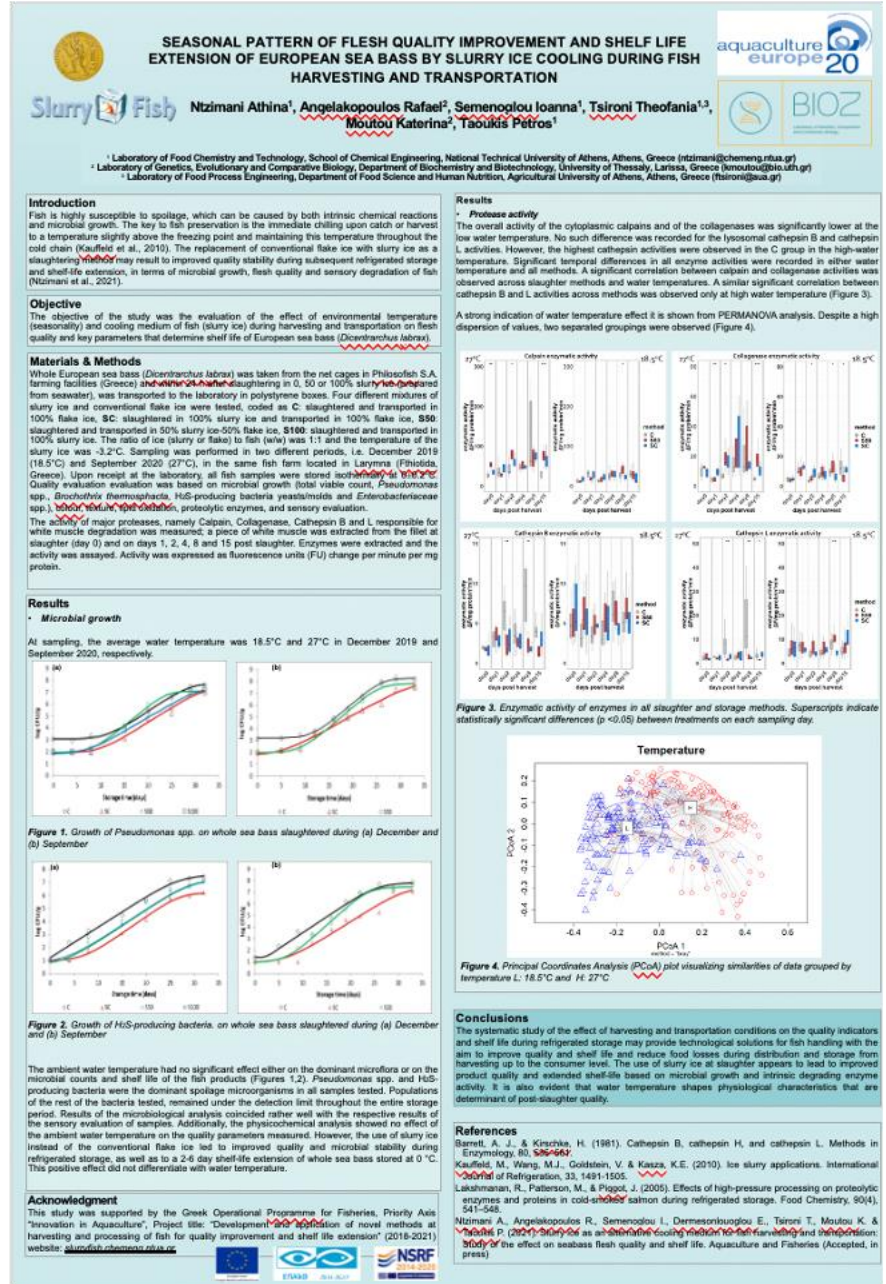
This study was supported by the Greek Operational Programme for Fisheries, Priority Axis "Innovation in Aquaculture", Project title: "Development and application of novel methods at harvesting and processing of fish for quality improvement and shelf life extension" (2018-2021) website: *slurryfish.chemeng.ntua.gr*

ΕΠΑλΘ 2014-2020

NSRF 2014-2020

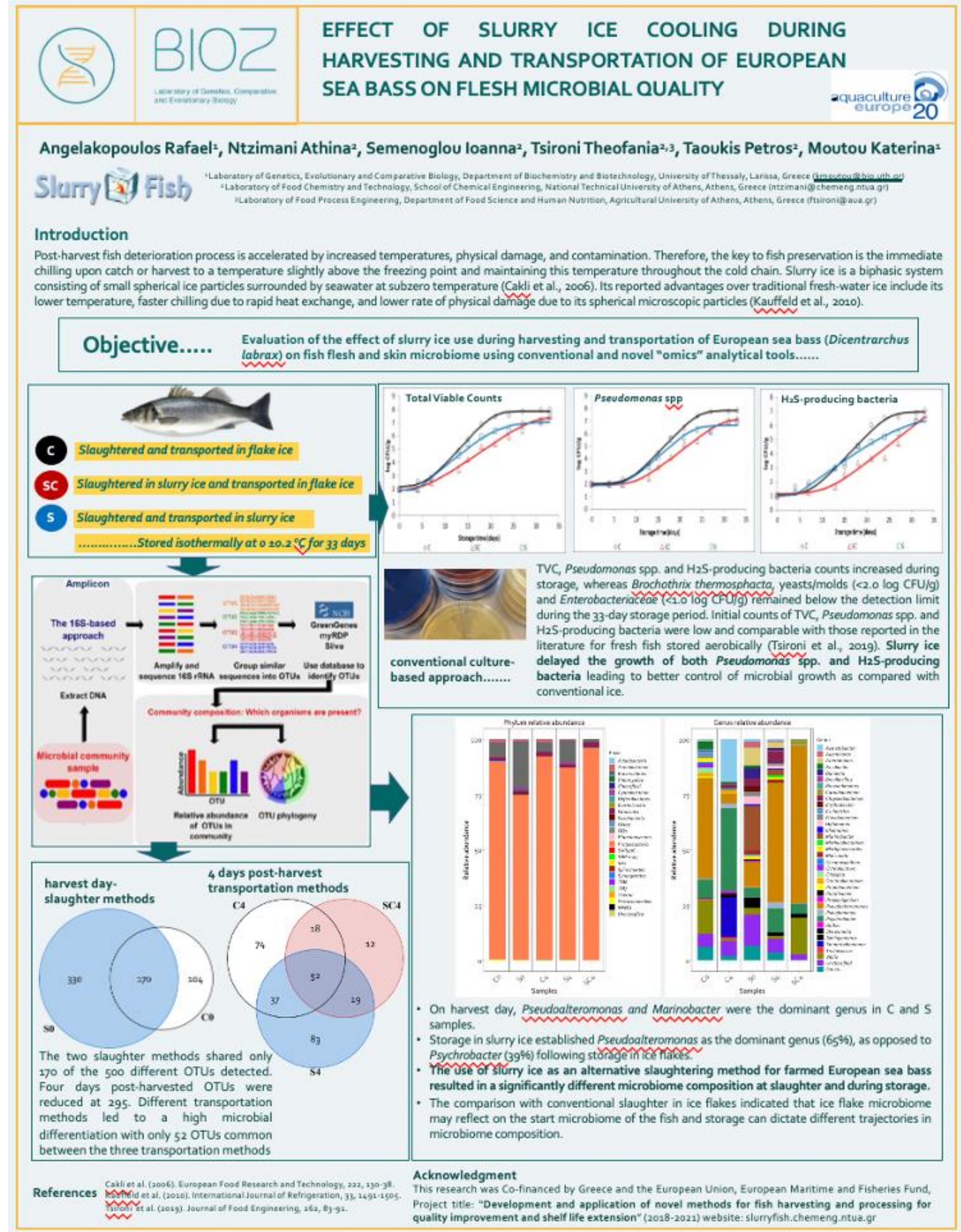
Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Ntzimani A., Angelakopoulos R., Semenoglou I., Tsironi T., Moutou K., Taoukis P. “Seasonal pattern of flesh quality improvement and shelf life extension of European sea bass by slurry ice cooling during fish harvesting and transportation”. Aquaculture Europe 2020. 12-15 April 2021, Virtual (Poster presentation).



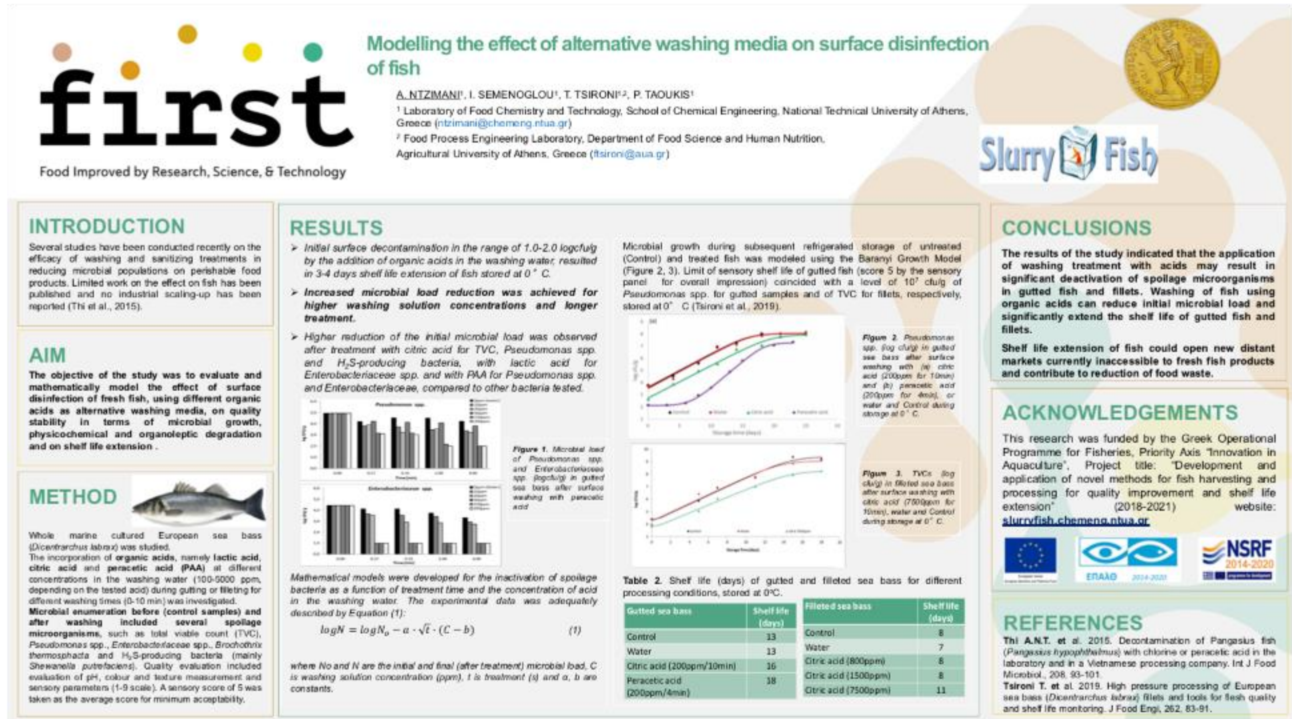
Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Angelakopoulos R., Ntzimani A., Semenoglou I., Tsironi T., Taoukis P., Moutou K. “Effect of slurry ice cooling during harvesting and transportation of European sea bass on flesh microbial quality”. Aquaculture Europe 2020. 12-15 April 2021, Virtual (Poster presentation).



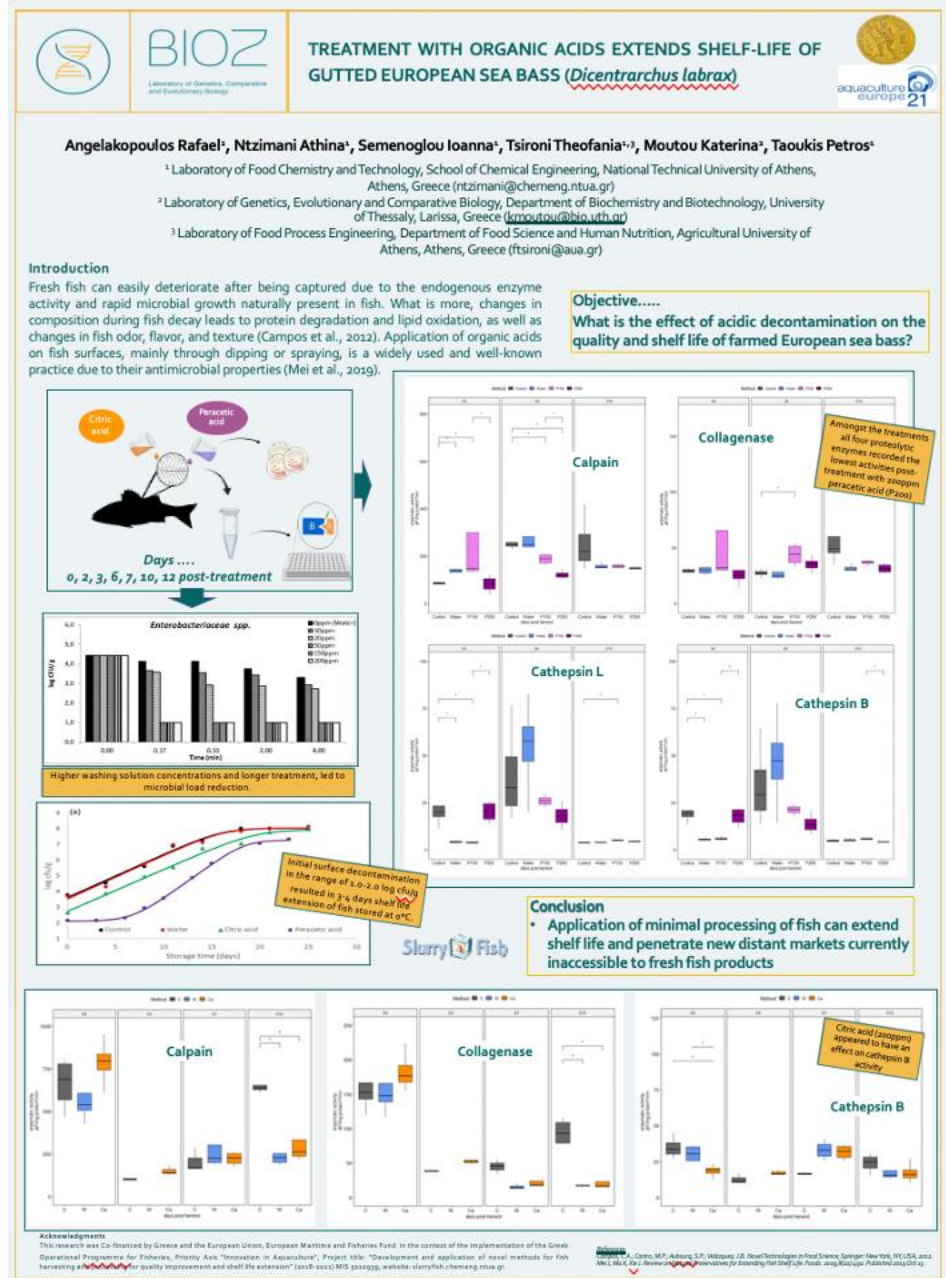
Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Ntzimani A., Semenoglou I., Tsironi T., Taoukis P. “Modelling the effect of alternative washing media on surface disinfection of fish”. IFT annual Meeting 2021. 18-21 July 2021, Vitrual (Poster presentation).



Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Angelakopoulos R., Ntzimani A., Semenoglou I., Tsironi T., Taoukis P., Moutou K. “Treatment with organic acids extends shelf-life of gutted European sea bass”. Aquaculture Europe 2021. 4-7 October 2021, Madeira, Portugal (Poster presentation).



Ευρωπαϊκή Ένωση
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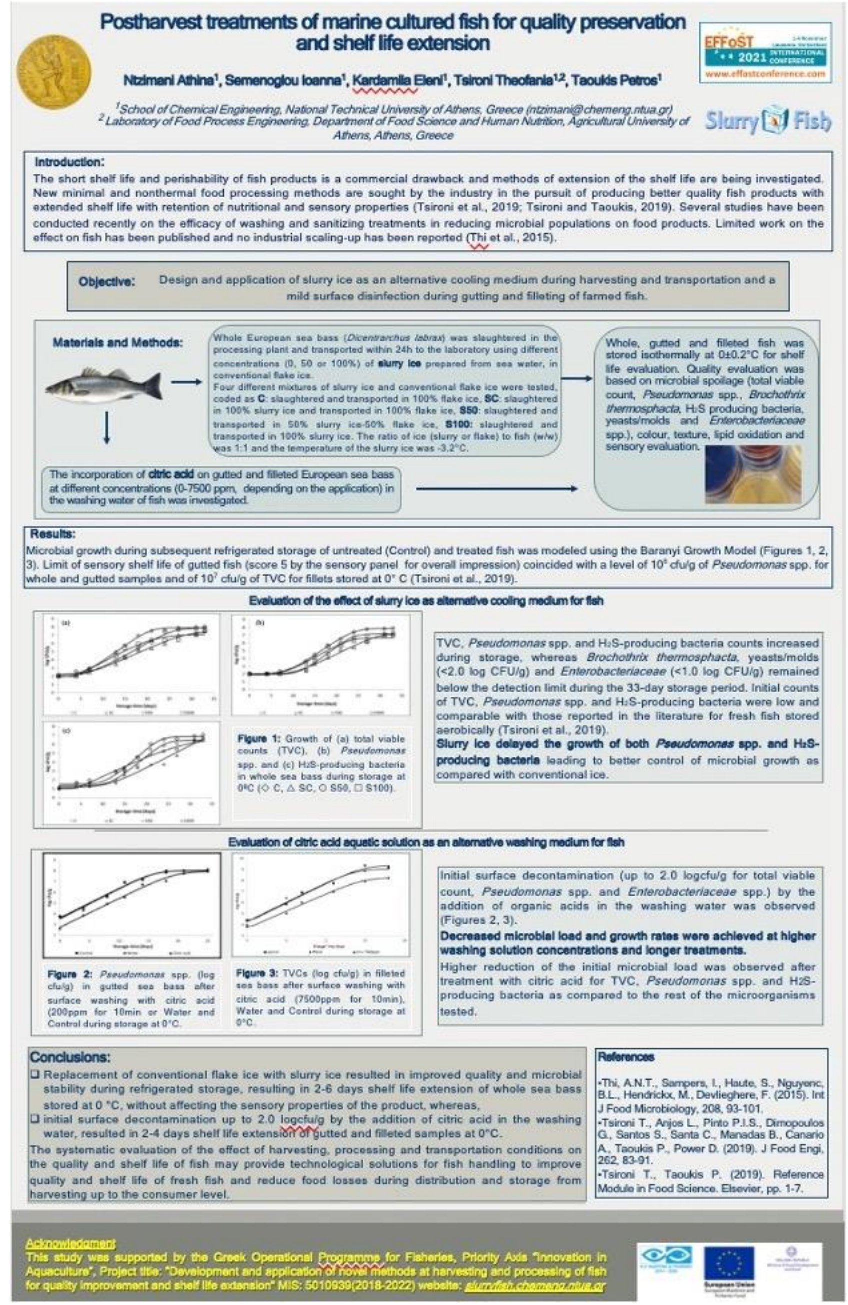
ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη
Slurry Fish
ΟΠΣ 5010939

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Ntzimani A., Semenoglou I., Kardamila E., Dermesonlouoglou E., Tsironi T., Taoukis P. "Postharvest treatments of marine cultured fish for quality preservation and shelf life extension". EFFoST2021 International Conference. 1-4 November 2021, Lausanne, Switzerland (Poster presentation).



Postharvest treatments of marine cultured fish for quality preservation and shelf life extension

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EFFoST 2021 International Conference www.effostconference.com

Slurry Fish

Introduction:
The short shelf life and perishability of fish products is a commercial drawback and methods of extension of the shelf life are being investigated. New minimal and nonthermal food processing methods are sought by the industry in the pursuit of producing better quality fish products with extended shelf life with retention of nutritional and sensory properties (Tsironi et al., 2019; Tsironi and Taoukis, 2019). Several studies have been conducted recently on the efficacy of washing and sanitizing treatments in reducing microbial populations on food products. Limited work on the effect on fish has been published and no industrial scaling-up has been reported (Thi et al., 2015).

Objective: Design and application of slurry ice as an alternative cooling medium during harvesting and transportation and a mild surface disinfection during gutting and filleting of farmed fish.

Materials and Methods:

Whole European sea bass (*Dicentrarchus labrax*) was slaughtered in the processing plant and transported within 24h to the laboratory using different concentrations (0, 50 or 100%) of **slurry ice** prepared from sea water, in conventional flake ice.
Four different mixtures of slurry ice and conventional flake ice were tested, coded as **C**: slaughtered and transported in 100% flake ice, **SC**: slaughtered in 100% slurry ice and transported in 100% flake ice, **S50**: slaughtered and transported in 50% slurry ice-50% flake ice, **S100**: slaughtered and transported in 100% slurry ice. The ratio of ice (slurry or flake) to fish (w/w) was 1:1 and the temperature of the slurry ice was -3.2°C.

The incorporation of **citric acid** on gutted and filleted European sea bass at different concentrations (0-7500 ppm, depending on the application) in the washing water of fish was investigated.

Whole, gutted and filleted fish was stored isothermally at 0±0.2°C for shelf life evaluation. Quality evaluation was based on microbial spoilage (total viable count, *Pseudomonas* spp., *Brochothrix thermosphacta*, H_2S producing bacteria, yeasts/molds and *Enterobacteriaceae* spp.), colour, texture, lipid oxidation and sensory evaluation.

Results:
Microbial growth during subsequent refrigerated storage of untreated (Control) and treated fish was modeled using the Baranyi Growth Model (Figures 1, 2, 3). Limit of sensory shelf life of gutted fish (score 5 by the sensory panel for overall impression) coincided with a level of 10^8 cfu/g of *Pseudomonas* spp. for whole and gutted samples and of 10^7 cfu/g of TVC for fillets stored at 0° C (Tsironi et al., 2019).

Evaluation of the effect of slurry ice as alternative cooling medium for fish

Figure 1: Growth of (a) total viable counts (TVC), (b) *Pseudomonas* spp. and (c) H_2S-producing bacteria in whole sea bass during storage at 0ºC (◇ C, △ SC, ○ S50, □ S100).

TVC, *Pseudomonas* spp. and H_2S-producing bacteria counts increased during storage, whereas *Brochothrix thermosphacta*, yeasts/molds (<2.0 log CFU/g) and *Enterobacteriaceae* (<1.0 log CFU/g) remained below the detection limit during the 33-day storage period. Initial counts of TVC, *Pseudomonas* spp. and H_2S-producing bacteria were low and comparable with those reported in the literature for fresh fish stored aerobically (Tsironi et al., 2019).
Slurry ice delayed the growth of both *Pseudomonas* spp. and H_2S-producing bacteria leading to better control of microbial growth as compared with conventional ice.

Evaluation of citric acid aquatic solution as an alternative washing medium for fish

Figure 2: *Pseudomonas* spp. (log cfu/g) in gutted sea bass after surface washing with citric acid (200ppm for 10min or Water and Control during storage at 0°C.

Figure 3: TVCs (log cfu/g) in filleted sea bass after surface washing with citric acid (7500ppm for 10min), Water and Control during storage at 0°C.

Initial surface decontamination (up to 2.0 logcfu/g for total viable count, *Pseudomonas* spp. and *Enterobacteriaceae* spp.) by the addition of organic acids in the washing water was observed (Figures 2, 3).
Decreased microbial load and growth rates were achieved at higher washing solution concentrations and longer treatments.
Higher reduction of the initial microbial load was observed after treatment with citric acid for TVC, *Pseudomonas* spp. and H_2S-producing bacteria as compared to the rest of the microorganisms tested.

Conclusions:
- Replacement of conventional flake ice with slurry ice resulted in improved quality and microbial stability during refrigerated storage, resulting in 2-6 days shelf life extension of whole sea bass stored at 0 °C, without affecting the sensory properties of the product, whereas,
- initial surface decontamination up to 2.0 logcfu/g by the addition of citric acid in the washing water, resulted in 2-4 days shelf life extension of gutted and filleted samples at 0°C.

The systematic evaluation of the effect of harvesting, processing and transportation conditions on the quality and shelf life of fish may provide technological solutions for fish handling to improve quality and shelf life of fresh fish and reduce food losses during distribution and storage from harvesting up to the consumer level.

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Acknowledgment
This study was supported by the Greek Operational Programme for Fisheries, Priority Axis "Innovation in Aquaculture", Project title: "Development and application of novel methods at harvesting and processing of fish for quality improvement and shelf life extension" MIS: 5010939(2018-2022) website: slurryfish.chemeng.ntua.gr

Διάχυση αποτελεσμάτων
(παρουσιάσεις σε επιστημονικά συνέδρια)

Ntzimani A., Angelakopoulos R., Semenoglou I., Stavropoulou N., Dermesonlouoglou E., Tsironi T., Xidia D., Liberis N., Moutou K., Taoukis P. “Development and application of novel methods for fish harvesting and processing for quality preservation and shelf life extension”. HydroMedit 2021. 4-6 November 2021, Vitrual (Oral presentation).

Development and application of novel methods for fish harvesting and processing for quality preservation and shelf life extension

Ntzimani A.[1], Angelakopoulos R.[2], Semenoglou I.[1], Stavropoulou N.[1], Dermesonlouoglou E.[1], Tsironi T.[1,3], Xidia D.[4], Liberis N.[4], Moutou K.[2], Taoukis P.[1]

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Διάχυση αποτελεσμάτων

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