

ICAR - ALL INDIA CO-ORDINATED RESEARCH PROJECT ON POST-HARVEST ENGINEERING & TECHNOLOGY

Department of Fish Processing Technology College of Fisheries, KVAFSU (B), Mangalore

The Post-Harvest Engineering & Technology scheme was sanctioned to the Department of Fish Processing Technology, College of Fisheries by the Indian Council of Agricultural Research (ICAR), Department of Agricultural Research & Education, Ministry of Agriculture, Government of India on October, 2009 under its XI plan of All India Coordinated Research Project programme.

Mandate Crop/commodity: Marine and fresh water fish for west coast of India

The center will cater to the needs of developing, disseminating and promoting the fish processing technologies for the west coast of India with following specific thrust areas

- Improving the quality of fish products by using traditional methods of fish processing, preservation of cured fish products.
- To identify the cost-efficient methods of product development and preservation by integrating the community knowledge with scientific expertise.
- To develop processes, products and control of infestation and spoilage during storage by using natural and chemical preservatives, furthermore traps are used to control insects or pests etc.,
- Development and popularization of suitable technologies for the utilization of low cost fishery resources.
- To gain acceptance of domestic markets by converting them in to various attractive value added products.
- In the domestic urban market, ready-to-eat attractively packed convenience foods are of great demand. Hence the main focus in this plan is to develop value added products such as minced based products, frozen fishery products and extruded products.
- To effectively utilize seafood industry waste by producing bioactive compounds, nutraceuticals and livestock/ aqua feed.
- To develop natural antioxidants and antimicrobial agents to preserve fishery products from the waste generated by Agro processing industries.

Details of the Faculty

	<p>Dr. C.V. Raju Professor & Head, FPT PI, ICAR-AICRP on PHET M.F.Sc. , Ph.D. (Fish Processing Technology) Area of Specialization : Canning , Value addition Email : cvraj@hotmail.com Contact No : 9449055439, 0824-2421990 (O), 0824-2215939 (R) Fax: +91824-2421990</p>
	<p>Dr. I. P. Lakshmisha Senior Scientist, F.M., ICAR-AICRP on PHET M.F.Sc., Ph.D. (Post-Harvest Technology) Area of specialization: Process Biochemistry, Natural Preservatives, Utilization of Fish Waste & Value Addition Email : iplaxmish@gmail.com Contact No: 9448300682, 0824-2427898(O) Fax: +91824-2421990</p>
	<p>Dr. Arun Kumar Prakash, M.Tech., Ph.D. Scientist (ASPE) ICAR-AICRP on PHET, Area of specialization : Process Engineering, Product Development Mob.: 09036105658 Email: uppinarun@gmail.com Fax: +91824-2421990</p>
	<p>Ms. Amitha Scientist (PHT) ICAR-AICRP on PHET, Area of specialization : Fish Processing Technology, Fish waste utilisation Mob.: 0932605458 Email: amithapoojary27@gmail.com Fax: +91824-2421990</p>

	<p>Mr. D. P. Prakash Technical T-I, ICAR-AICRP on PHET M.Sc. Email : prakashdp1974@gmail.com Contact No: 7899630807</p>
	<p>Mrs. Meera M.S Technical T-II(3), ICAR-AICRP on PHET M.Sc. Email : meerams1910@gmail.com Contact No: 8050236690</p>
	<p>Ms. Lavanya Technical T-II(3), ICAR-AICRP on PHET B.Sc Email : lavanyagp2016@gmail.com Contact No : 9535451670</p>
	<p>Mrs. Usha Steno Typist / Jr. Clerk, ICAR-AICRP on PHET M.Com Email : ushaanchan22@gmail.com Contact No: 9448539393</p>

Projects approved under ICAR-AICRP on PHET (ICAR-CIPHET, Ludhiana)

Completed Projects:

1. Enhancement of shelf life of smoked fish sausage using natural preservatives
2. Development of women friendly fish vending and display unit
3. Development of Fish Ham and Patty using Natural Antioxidant Extracts
4. Development of fish chikuwa from low cost marine and fresh water fish and their shelf life study
5. Development of Fish Ham and Patty and its storage stability with Natural Antioxidant Extracts
6. Development of fish snacks using hybrid solar biomass powered dryer
7. Development of gender friendly refrigerated fish vending and display unit using solar energy
8. Technology for the production of silage using seafood industry waste for animal feed

On-going Projects:

1. Production of Fish oil concentrate Rich in Omega-3 Fatty acids
2. Development of small scale Fish meat picking unit and its performance evaluation
3. Design and development of microprocessor controlled aspirated heat processor for the production of ready to eat fishery products
4. Design and development of pedal operated fish de-scaling cum slicing Machine
5. Utilization of filleting waste or skeletal frames as a source of essential minerals

Achievements/Technologies developed

1. Women Friendly Fish Vending and Display Unit
2. Fish Ham and Patty using button mushroom
3. Smoked Fish Sausage Using Natural Preservatives
4. Fish snacks using hybrid solar biomass powered dryer

Women Friendly Fish Vending and Display Unit

The technology is the first of its kind in the country and addresses the issue of post-harvest loss in terms of extending the keeping quality of seafood and fresh water fishes with ice storage and avoid the drudgery of the fisher women in procuring fish on regular basis from various places in bulk. Generally icing of fish adds to cost and transportation expenses. Since this technology has well insulated storage space for fish, it reduces the ice melting rate, thereby reducing the selling cost incurred for ice. This technology extends the keeping quality of fish for 4 to 5 days and increases the marginal benefit to fish vendors. Also the technology helps to change the existing practice of unhygienic handling and marketing of fish.



Fish Ham and Patty using button mushroom

Fish ham may be described as small cubes of red meat tuna, minced mutton and dermal fat of pork, mixed with ground fish paste (as binding meat) and packed in synthetic casing, sealed and heat processed. The meat and fat pieces (cubes) form 50 to 60 % of the product, exhibiting a mosaic pattern, when it is cut into slices. The dominating feature of the meat pieces in the product, gives the name “fish

ham”. It is preserved at lower temperature. Shrimp chunks can be used as an alternative to meat to improve the flavor and integrity of fish ham slices when stored under refrigerated and frozen conditions. The ham packed in fibrous casing will have shelf life of 21 days at refrigerated temperature and nearly 90 days at cold storage.

Fish patty is formulated using button mushroom. Fish patty is a convenience ready-to-cook product, which can be directly eaten or used in fish burger as a base material. Mushroom is used as an attempt to improving nutritional quality and at the same time to reduce production cost of meat based patties. The shelf life of patty is around 20 days at refrigerated storage.



Ready-to-Eat Fish Ham in Sliced Form



Ready-to-Eat Fish Patty

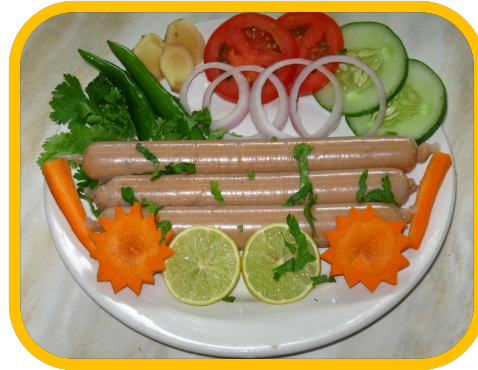
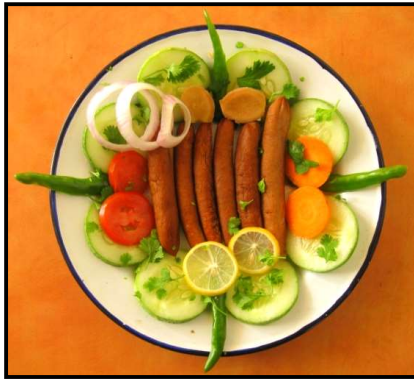
Smoked Fish Sausage Using Natural Preservatives

Fish Sausage as a ready-to-use food item has been extensively popular in Japan and has evinced a great deal of interest in India. Being a cheap, fish based, highly nutritious item, its high degree of acceptability is due to its several desirable quality characteristics such as appearance, color, taste, flavor and resilience. The advantage of fish sausage is that dark meat and flesh from acceptable species, such as whale etc, can be utilized fully.

Fish sausages in natural casing after subjecting to wood smoking at 70 °C for 2 hr, were studied for their keeping quality in chill storage at 5 ± 1 °C. Physical, chemical, microbiological and sensory tests were conducted in assessing the acceptability of the sausage at regular intervals. It was found that fish sausages in natural casing remained acceptable for 21 days. However, smoke treatment could enhance the shelf life to 28 days at the same temperature with or without preservatives. Hence smoke treatment can be considered as one of the best preservation methods, which increase the storage life of fish sausages in natural casing.

A case study was made on the quality and stability of cellulose casings in comparison to synthetic casing (Krehlon/poly vinylchloride), which showed that the cellulose casing can be considered as a very good substitute for synthetic casing as the cost of cellulose casing was found to

be 10 times cheaper than synthetic casing. The shelf life of smoked sausage in cellulose casings was revealed to be 40 days under refrigerated condition.



Ready-to-eat smoked fish sausage in natural Casing & cellulose casing

4. Fish snacks using hybrid solar biomass powered dryer

Innovative value added ready to fry dried anchovies were developed using solar biomass hybrid drier. The quality and storage stability of dried coated anchovy with standardized coating recipe was better compared to control. The coated sample was observed to have shelf life of 90days



Ready to eat fried anchovies

List of patents

- Patent Application no. 3646/CHE/2014 filed on 25.07.2014 for A system for Storing Displaying and Vending Foods.

List of technologies transferred.

1. Fish Patties and Fish Chikuwa were transferred to a women entrepreneur
2. Fish sausage in cellulose casing
3. Methods of Processing and Development of Value Added Fishery Products

List of technologies ready for commercialization

1. Design and fabrication of fish vending table for sale of fresh fish
2. Dried Masala coated Anchovies using Solar Drier
3. Smoked fish sausage in cellulose and natural casing
4. Extension of shelf life of fish steaks, fillets and whole fish using natural antioxidants and antimicrobial agents
5. Fish ham with shrimp chunks using fibrous and synthetic casings
6. Development of poultry feed using seafood industry waste
7. Methods of Processing and Development of Value Added Fishery Products

XII FIVE YEAR PLAN	APRIL 2017 TO MARCH 2020
FUNDING AGENCY	ICAR-CIPHET, LUDIANA, PUNJAB

Publications for the year 2012 to 2017

International level:

1. Prakasha Chandra Nayak, C.V. Raju, I. P. Lakshmisha, Singh, R. R., Sofi, F. R. 2015. Influence of Button Mushroom (*Agaricus bisporus*) on quality and refrigerated storage stability of patties prepared from Sutchi cat fish (*Pangasius hypophthalmus*). *Journal of Food Science and Technology*. 52(6): 3529-38.
2. Faisal Rashid Sofi, C. V. Raju, I. P. Lakshmisha, Rajkumar Ratankumar Singh. 2016. Antioxidant and antimicrobial properties of grape and papaya seed extracts and their application on the preservation of Indian Mackerel (*Rastrelliger Kanagurta*) during ice storage *Journal of Food Science and Technology*. 53 (1): 104-117.

3. Supreetha, B.U. Chandra, M. V and Shamasundar, B.A. 2015. Effect of setting on the properties of proteins from threadfin bream (*Nemipterus japonicus*) fish mince. International Journal of Current Research Review, Vol 7(18):19-24.
4. Chandra, M.V. and Shamasundar, B.A. 2015. Rheological properties of gelatin prepared from the swim bladders of freshwater fish *Catla catla*. Food Hydrocolloids, 48: 47-54.
5. Chandra M.V., Raju C.V. and Vijay Kumar Reddy S. 2014. Influence of heat penetration on the quality of canned ribbon fish (*Trichiurus lepturus*)” Journal of Food Processing and Preservation. 38,807-814.
6. Chandra M.V. and Shamasundar, B.A. 2014. Rheological and physico-chemical properties of gelatin extracted from the skin of a few species of freshwater carp. International Journal of Food Science and Technology. 49, 1758–1764.
7. Chandra M.V and Shamasundar, B.A. 2014. Texture profile analysis and functional properties of gelatin from the skin of three species of fresh water fish. International Journal of Food properties 18 (3), 572-584.
8. Chandra M.V. Shamasundar, B.A. and Ramesh Kumar 2013. Visco-elastic and flow properties of gelatin from the bone of fresh water fish (*Cirrhinus mrigala*) Journal of Food Science, 78(7):E1009-16

International Posters:

1. A Poster presentation was made on “Women Friendly Fish Vending and Display Unit”. Raju, C.V., & Lakshmisha, I.P., in Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition – Opportunities and Challenges, on 4 to 6, Dec, 2012
2. A poster was presented on “Biochemical and Microbiological Changes in Treated Minced Meat of Horse Mackerel (*Trachurus trachurus*)” Faisal R.S., Raju C.V., Lakshmisha I.P. & Singh R.R. in Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition – Opportunities and Challenges, on 4-6 Dec, 2012
3. A poster was presented on “Comparative studies on the quality of ice stored fatty and lean fish in indigenously developed women friendly fish vending and display unit” by Raju C.V., & Lakshmisha I.P. in an International symposium on

Greening Fisheries: Towards green technologies in fisheries”, which was held at Kochi, Kerala, India during 21-23, May, 2013.

4. A Poster presentation was made on Antioxidant and Antimicrobial Properties of Grape and Papaya Seed Extracts and their Application to Indian mackerel Preservation in DAE-BRNS Life Sciences Symposium (LSS-2015) on “Advances in Microbiology of Food, Agriculture, Health and Environment” organized by Bioscience Group, Bhabha Atomic Research Centre, Mumbai during Feb, 3-5 , 2015
5. A Poster presentation was made on “Studies on Smoke Preservation of Fish Sausage in Natural Casing”. Raju, C.V., & Lakshmisha, I.P., in an International workshop on Innovative food processing held at National Pingtung University of Science and technology, Pingtung, Taiwan during Oct 25 to 31st, 2015
6. Faisal R.S., Raju C.V., Lakshmisha I.P., Rehana, Dhanapal k., and Singh R.R. (2016) on “Synergistic effect of freezing and natural antioxidants on the quality of whole mackerel (*Rastrelliger kanagurta*) stored under frozen condition” in the International conference on “Emerging issues in quality and safety of fish and shellfish” organised by TNAU, Chennai, Tamil Nadu during 11th to 12th, August 2016.
7. Gayatri Pandey, Raju C.V., Lakshmisha I.P., Jagpal and Singh R.R. (2016) on Development of gender friendly refrigerated fish vending and display unit using solar energy to enhance the keeping quality of fish” in the International conference on “Emerging issues in quality and safety of fish and shellfish” organised by TNAU, Chennai, Tamil Nadu during 11th to 12th, August 2016.
8. A poster presentation on “Study on comparative evaluation of icing and solar energy operated refrigerated system in fish vending cum display unit on the quality of marine fishes during storage” by C.V. Raju., I.P. Lakshmisha, P. Arun Kumar, Amitha, P. Gayatri, in 11th Indian Fisheries and Aquaculture Forum International Conference on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety, 21st to 24th November 2017, Kochi, Kerala, SF PO 40, Page. 419
9. I.P. Lakshmisha, C.V. Raju., P. Arun Kumar., Richa Choudhary, on “Study on effect of grape seed extract in enhancing the shelf life of fish sausage” by in 11th Indian Fisheries and Aquaculture Forum an International Conference on

Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety, 21st to 24th November 2017, Kochi, Kerala, AV OR 40, Page. 358.

10. Oral Presentation on “Ileal digestability assay of broiler chicks fed with soybean meal and fish silage as protein supplement in poultry diet” by Rehana Raj, C.V. Raju., I.P. Lakshmisha, and Jagpal, in 11th Indian Fisheries and Aquaculture Forum International Conference on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety, 21st to 24th November 2017, Kochi, Kerala, AV OR 47, Page. 362.
11. A poster presentation on “Antimicrobial and antioxidative impact of pomegranate peel extract on extending the shelf life of fish sausage” by Raju, C.V., D’Souza, P.J., Kumar, A.P., and Lakshmisha, I.P. in an International conference on Recent Trends in Agriculture, Biotechnology and Food Processing organized by College of Agriculture, University of Agriculture, Hassan, 5th to 7th July, 2017. (2017).
12. A poster presentation on “Storage stability of masala coated anchovies (*Stelophorus commersonii*) dried using hybrid solar biomass drier” by C.V. Raju, C. Aylwin, I.P. Lakshmisha, P. Arun Kumar, in 11th Indian Fisheries and Aquaculture Forum International Conference on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety, 21st to 24th November 2017, Kochi, Kerala, AV PO 25, Page. 376.
13. A poster presentation on “Effect of edible coatings on the quality and shelf life of refrigerated Indian mackerel (*Rastrelliger Kanagurta*)” by C.V. Raju, V. Deepa Nayak, P. Arun Kumar, I.P. Lakshmisha, in 11th Indian Fisheries and Aquaculture Forum International Conference on Fostering Innovations in Fisheries and Aquaculture Focus on Sustainability and Safety, 21st to 24th November 2017, Kochi, Kerala, AV PO 26, Page. 377.
14. Raju, C.V., Kumar, A.P., Lakshmisha, I.P., and Pandey, G. 2016. Effect of intervention of solar energy operated refrigerated system in fish vending cum display unit on quality of marine fishes during storage. 9th Annual KSTA Conference on Science, Technology and Innovations in the 21st Century, KSTA, Govt. of Karnataka and Christ University, Bangalore, 20th to 21st December, INTS057.

Best International Poster:

15. Jagpal, Raj, C.V. Raju., I.P. Lakshmisha., Rehana R, Singh R.R. and G. Pandey (2016) on Antioxidant activity and efficacy of pomegranate and orange peel extracts on the storage stability of fish ham” in the International conference on “Emerging issues in quality and safety of fish and shellfish” organised by TNAU, Chennai, Tamil Nadu during 11th to 12th, August 2016.

National level:

1. Lakshmisha I.P., Sankar. T.V., Anandan. R., Geethalakshmi V. & Jose Joseph., (2012). “Changes in Muscle Protein during Fat Oxidation in Indian Mackerel *Rastrelliger kanagurta* (Cuvier, 1817) and Threadfin Bream *Nemipterus japonicus* (Bloch, 1791) under Accelerated Conditions” Vol. 49 (2), pp 147-154 *Fishery Technology*
2. Lakshmisha I.P., Sankar. T.V., Anandan. R., & Geethalakshmi V..(2014) Biochemical Studies on Oxidative Deterioration of Lipid Profile in Indian Mackerel 115 (*Rastrelliger kanagurta*) Vol 7(1), *Trends in Biosciences*. Pp 115-12.
3. F. R. Sofi, C. V. Raju, I. P. Lakshmisha and R. R. Singh. 2014. Antioxidant activity and inhibitory effects of Grape and Papaya Seed extracts against lipid oxidation in model system. *Eco. Env. & Cons.* 20 (Suppl.): S367-S372
4. Jaya Naik, C. V. Raju and A. R. Manjunatha. 2014. Studies on the quality of canned fishery products prepared using ice stored Mackerel and Pink Perch. *Ind. J. Sci. Res. and Tech.* 2 (4): 71-78.
5. Faisal R. S., Raju C. V., Lakshmisha I. P., Rajkumar R. S. and Saba K. K. 2015. Comparative studies on antioxidant and antimicrobial properties of Grape and Papaya Seed extracts using In-Vitro Studies. *International Journal of Pharma and Bio Sciences*. 6(3): (B) 812-823.
6. Rajkumar Ratankumar Singh, C. V. Raju, I. P. Lakshmisha, Faisal Rashid Sofi, Jag Pal and Aylwin Cherian. 2016. Analysis of In-Vitro antioxidant activities of Crude Potato Peel and Ginger extract. *National Journal of Life Science*. 13 (1): 65-70.
7. Gayatri Pandey, C. V. Raju, Jag Pal, Shobha Rawat, Mahesh Chand Sonwal and Hunuman Prasad Pandey. 2017. Comparative study of changes in the quality

attributes of Indian Mackerel (*Rastrelliger Kanagurta*) and Pink Perch (*Nemipterus japonicus*) stored in solar operated refrigerated fish vending unit. *Journal of Entomology and Zoology Studies*, 5 (6): 616-619

8. Devananda Uchoi, C. V. Raju, I. P. Lakshmisha, R. R. Singh and K. Elavarasan. 2017. Antioxidative effect of Pineapple Peel extracts in refrigerated storage of Indian Mackerel. *Fishery Technology* 54: 42-50.
9. Jag Pal, C. V. Raju, I. P. Lakshmisha, Gayatri Pandey, Rehana Raj and Rajkumar Ratankumar Singh. 2017. Antioxidant activity of Pomegranate Peel extract and its effect on storage stability of cooked meat model system of Indian Mackerel (*Rastrelliger Kanagurta*) stored at 4±2° C. *Biochem. Cell. Arch.* 17 (1): 183-187.
10. Jag Pal, C. V. Raju, Lakshmisha I. P., Arun Kumar Prakash, Gayatri Pandey, Rajkumar Ratan Kumar Singh, Sarojini A and Amitha. 2017. Comparatives study of antioxidant activity and total phenolic contents of pomegranate and orange peels extracts. *Journal of Pharmacognosy and Phytochemistry*, 6 (6): 1359-1362
11. ಸಿ. ವಿ. ರಾಜು, ಪಿ. ಅರುಣ್ ಕುಮಾರ್ ಮತ್ತು ಐ. ಪಿ. ಲಕ್ಷ್ಮೀಶ. 2016. ಮೀನಿನ ಸಂಗ್ರಹಣಾವಧಿಯ ಗುಣಮಟ್ಟ ವೃದ್ಧಿಗಾಗಿ ಸೌರಶಕ್ತಿಯಾಧಾರಿತ ಶೈತ್ಯೀಕರಣದ ಮೀನು ಮಾರಾಟ ಮತ್ತು ಪ್ರದರ್ಶನ ಘಟಕದ ಅಭಿವೃದ್ಧಿ. *International Journal of Kannada Research*: 2 (4): 137-143.

III. Books published:

Kannada

1. ಡಾ|| ಸಿ. ವಿ. ರಾಜು ಮತ್ತು ಡಾ|| ಐ. ಪಿ. ಲಕ್ಷ್ಮೀಶ. 2015. ಮೌಲ್ಯವರ್ಧಿತ ಮೀನಿನ ಉತ್ಪನ್ನಗಳು, ಉಪಉತ್ಪನ್ನಗಳು ಮತ್ತು ಉದ್ಯಮಶೀಲತೆಗೆ ಇರುವ ಅವಕಾಶಗಳು. ವಿಶೇಷ ಪ್ರಕಟಣೆ: ವಿಸ್ತರಣ ನಿರ್ದೇಶನಾಲಯ, ಕೆ.ವಿ.ಎ.ಎಫ್.ಎಸ್.ಯು, ಬೀದರ್.
2. ಡಾ|| ಸಿ. ವಿ. ರಾಜು, ಡಾ|| ಅರುಣ್ ಕುಮಾರ್ ಮತ್ತು ಡಾ|| ಐ. ಪಿ. ಲಕ್ಷ್ಮೀಶ. 2017. ಮೀನಿನ ಸ್ವಾದಿಷ್ಟ ತಿನಿಸುಗಳು (ಆರೋಗ್ಯಕ್ಕೆ ಹಾಗೂ ಸವಿರುಚಿಗೆ ತಕ್ಕ ತಯಾರಿ) ಪ್ರಕಟಣೆ: ಕೆ.ವಿ.ಎ.ಎಫ್.ಎಸ್.ಯು, ಮತ್ತು ಭಾ.ಕೃ.ಸಂ.ಮಂ. ಅಖಿಲ ಭಾರತ ಸಹ-ಸಂಘಟಿತ ಸಂಶೋಧನಾ ಯೋಜನೆ. ಕೊಯ್ಲಿನೋತ್ತರ ಅಭಿಯಂತರು ಮತ್ತು ತಂತ್ರಜ್ಞಾನ ವಿಭಾಗ ಮೀನುಗಾರಿಕೆ ಮಹಾವಿದ್ಯಾಲಯ, ಮಂಗಳೂರು.

English

3. Dr. C. V. Raju & Dr. I. P. Lakshmisha, 2013. Hand book on Quality Assessment of Fish and Fishery products. Published by ICAR-AICRP on PHET, Dept. of FPT, CoF, KVAFSU, Mangaluru.

4. C. V. Raju, Arun Kumar P., & I. P. Lakshmisha. 2017. Delicious Fish Foods (Fish for healthy meal). Published by: ICAR-AICRP (PHET), Dept. of Fish Processing Technology, CoF, KVAFSU, Mangaluru and released in 32nd Annual workshop of ICAR-AICRP (PHET), Ludhiana on 7th-9th March 2017.
5. Chandra M. V and B.A. Shamasundar, 2008. Fish processing waste: Management and Utilization. In: Food Processing Waste Management Treatment and Utilization Technology. Etd. V. K. Joshi; New India Publishing Agency
6. Chandra M. V., and B.A. Shamasundar, 2012. Surimi and Surimi Based Products. In: Advances in Harvest and Postharvest Technology of Fish. Edt. Nambudari and K.V. Peter; New India Publishing Agency

Hindi

7. Arun Kumar, P., Raju, C. V., and Lakshmisha, I. P. 2017. Swadist Machike Pakhwana (Recipe Book in Hindi), Published by: ICAR-AICRP (PHET), Dept. of Fish Processing Technology, CoF, KVAFSU, Mangaluru and released in 32nd Annual workshop of ICAR-AICRP (PHET), Ludhiana on 7th-9th March 2017.

IV. Extension bulletins:

1. Raju C. V., Lakshmisha I. P. and Nanda S. K. 2010. Fish sausage in natural casing. ICAR-AICRP on PHET, ICAR-CIPHET and Dept. of Fish Processing Technology, KVAFSU, Mangaluru.
2. Raju C. V., & I. P. Lakshmisha. 2015. Fish ham-A value added product. ICAR-AICRP on PHET, ICAR-CIPHET and Dept. of Fish Processing Technology, KVAFSU, Mangaluru.
3. Raju C. V., Lakshmisha I. P., Prakasha D. P., Meera M. S., & Joyleen. 2016. Fish patties formulated using Button Mushroom. ICAR-AICRP on PHET, ICAR-CIPHET and Dept. of Fish Processing Technology, KVAFSU, Mangaluru.
4. Raju C. V. & I. P. Lakshmisha. 2016 Dry Fish Production and Marketing (Kannada). ICAR-AICRP on PHET and Dept. of Fish Processing Technology, College of Fisheries, KVAFSU(B), Mangaluru published in Mathsyamela, Mangalore.
5. Raju C. V. & I. P. Lakshmisha. 2018. Success story of Fish Vending cum Display Unit. ICAR-AICRP on PHET, ICAR-CIPHET and Dept. of Fish Processing

Technology, KVAFSU(B), Mangaluru and released in 33rd Annual workshop of ICAR-AICRP (PHET), JAU, Junagadh on 23rd to 25th Jan 2018.

V. Popular articles published in leading dailies:

1. Raju C. V., and Lakshmisha I. P. 2012. Women Friendly Fish Vending and Display Unit. Value fish in national conference on Research, Production & Marketing of value added fish products present status & future directions. Published by CSIR-CFTRI, Mysore. Page No. 101-103

VI. Training Programmes attended:

1. One month of in plant Training in Fish Processing Technology in E.U. and HACCP approved processing plants at Mangalore, India. I have diligently worked with Production and Marketing Managers on Production Process, Marketing and Management Process of different fish Products which were exported to European Union., U.S. and some South-east Asian countries.
2. 10 days ICAR short course on “Marketing research for value chain in fisheries”. Organized by CIFT during 1 – 10 Oct, 2013, funded by ICAR, New Delhi, India.
3. 21 days workshop on “Reclamation of saline and alkaline soils through aquaculture” organized by College of Fisheries, KVAFSU (B), Mangalore held during 6-26, Nov. 2013 funded by ICAR, New Delhi, India,
4. 21 days’ workshop on “Recent advances in the development of nutraceuticals, health foods and fish feed from fish & shellfish processing discards”. Organized by CIFT during 10th Nov – 1stDec, 2014, funded by ICAR, New Delhi, India.
5. Training on “Laboratory Quality Management System and Internal Audit as per ISO/IEC-17025 and NABL requirements” at Standardization Testing and Quality Certification Directorate, Ministry of Electronics and Information Technology, Govt. of India, Bangalore.
6. Training on “Instrumental Techniques in Biochemical Analysis of Fish”, ICAR-Central Institute of Fisheries Technology, Cochin, 2005.
7. Training on “HACCP Concepts”, ICAR-Central Institute of Fisheries Technology, Cochin, 2005.
8. Training in extension work in different villages, where I’ve instructed around 130 Fishermen on Technological aspects of Fish Gear Design, Operation and Mending, Product Development like Preparation of fish pickles, Fish chutni powder, Fish cutlets, Sun dried products etc.

9. Training survey on socio-economic conditions of fishermen community and Utilization of innovative technologies for effective fishing in different villages, in and around Mangalore and Udupi, West coast, India.

VII. Resource person for various activities

- Lecture on training program for fisher folks on “creating awareness on hygienic practice and processing of fishes for fisherwomen’s” organized by Department of Fisheries, Govt. of Karnataka, at Mangalore on 23rd Jan 2017.
- Lecture on a training program of “Skill Enhancement in the Marine Sector (SEMS) for sustainable export opportunities: Enhanced Official control by State and UTs Fisheries Departments” organized by Export Inspection Council, Ministry of Commerce & Industry at CMFRI, Mangalore on 28 SEP 2018
- Training and demonstration in a NFDB sponsored program on Hygienic handling, preparation of fish value added products, solar drying of fish to the fisher folks of coastal Karnataka organized by MFRIC, KVAFSU (B) Ankola. on 19th to 20th Feb, 2014
- Training and demonstration in a NFDB sponsored program on “Preparation of fish, prawn pickle and fryumes” organized by KVK, Brahmavar, Udupi on 13-15, Mar, 2017

VIII. Patents Filed (Application no. 3646/CHE/2014):

16. Raju, C.V. & Lakshmisha I.P., “Fish vending and Display Unit” Indian Patent Application no. 3646/CHE/2014 filed on 25.07.2014 under review

IX. Posters:

i. Best National Poster

1. Nischitha, V.S., Lakshmisha, I.P., Raju, C.V., Prakash & Roseline, L. (2018). Effect of grape seed extract (GSE) on the storage stability of fish ham during frozen storage, National level seminar on "Food & Human Welfare-Future & Beyond" Organized by the Department of Botany, Chemistry, Microbiology & Zoology, St. Agnes College Mangaluru on 15th & 16th of February 2018.

National posters:

2. Devananda Uchoi, C. V. Raju, Lakshmisha I. P., R. K. Ratankumar Singh and Elavarason K. 2016. Pineapple Peel extract: A natural antioxidant and its effects on lipid oxidation in India. Mackerel (*R. Kanagurta*) steaks during refrigerated storage. National Seminar on Fisheries and Aquaculture: Livelihood Security, sustainability and conservation. Published by North east society for Fisheries and Aquaculture at COF, Lembuchera, Tripura (W) Page No. 99.

X. Folders:

Sl.no.	Type of publication	Month & Year	Authors	Title of the Publication
1	Kannada Folder	March, 2016	C.V. Raju & I.P. Lakshmisha	Dabbi jopaasane vidhanadinda menu mattu meenina uthpannagala jopasne
2	Kannada Folder	March, 2016	C.V. Raju & I.P. Lakshmisha	Vana meenu uthpadane mattu maarata
3	Kannada Folder	March, 2016	C.V. Raju & I.P. Lakshmisha	Mahila snehi meenu maarata mattu pradharshana gataka
4	Kannada Folder	March, 2016	C.V. Raju & I.P. Lakshmisha	Hogeyaadisida meenugala jopaasane

XI. Abstracts published

Seminars

1. Devananda Uchoi, C. V. Raju, Lakshmisha I. P., R. K. Ratankumar Singh and Elavarason K. 2016. Pineapple Peel extract: A natural antioxidant and its effects on lipid oxidation in India. Mackerel (*R. Kanagurta*) steaks during refrigerated storage. National Seminar on Fisheries and Aquaculture: Livelihood Security, sustainability and conservation. Published by North east society for Fisheries and Aquaculture at COF, Lembuchera, Tripura (W) Page No. 99.
2. C.V. Raju, P. Arun Kumar and I.P. Lakshmisha, (2016). Abstract on: Development of Refrigerated fish vending and display unit to enhance the keeping quality of

fish using solar energy has been published at 12th Kannada Vijnana Sammelana, organized by Swadeshi Vijnana Andolana- Karnataka and KVAFSU, Bidar during 15th to 17th September, 2016.

Symposia

1. Faisal R. S., S. M. Zofair, C. V. Raju & I. P. Lakshmisha. 2012. Biochemical and Microbiological changes in treated minced meat of Horse Mackerel (*Trachurus trachurus*). *Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition-opportunities and challenges*, AFSIB, Mangalore. Page No. 136
2. Lakshmisha I. P., & C. V. Raju. 2012. Optimization of process temperature and time for fish ham in Fibrous Casing. *Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition-opportunities and challenges*, AFSIB, Mangalore. Page No. 140
3. Raju C. V. & I. P. Lakshmisha. 2012. Studies on the quality of Fish Sausage in cellulose casing with smoke treatment. *Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition-opportunities and challenges*, AFSIB, Mangalore. Page No. 149
4. Raju C. V. & I. P. Lakshmisha. 2012. Women friendly Fish Vending and Display Unit. *Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition-opportunities and challenges*, AFSIB, Mangalore. Page No. 81
5. C. V. Raju & I. P. Lakshmisha. 2013. Comparative studies on the quality of ice-stored fish in indigenously developed women friendly fish vending and display units. International Symposium on 21st-23rd May 2013 published by CIFT, Cochin. Page No. 155.
6. C. N. Prakash, I. P. Lakshmisha, & C. V. Raju. 2013. Quality and refrigerated storage stability of patties prepared from striped cat fish and button mushroom. International Symposium on 21-23 May 2013 published by CIFT, Cochin. Page No. 100.

Conferences

1. Raju, C.V., Kumar, A.P., Lakshmisha, I.P., and Pandey, G. 2016. Effect of intervention of solar energy operated refrigerated system in fish vending cum display unit on quality of marine fishes during storage. *9th Annual KSTA Conference on Science, Technology and Innovations in the 21st Century*,

KSTA, Govt. of Karnataka and Christ University, Bangalore, 20th to 21st December, INTS057.

2. Jag Pal, C. V. Raju, P. Lakshmisha, Rehana Raj, R. Ratan Kumar Singh and G. Pandey, 2016. Antioxidant activity and efficacy of pomegranate and orange peel extracts on the storage stability of fish ham. *International Conference on EIQASFISH*. FQ-7P. P. 39.
3. Gayatri Pandey, C. V. Raju, I. P. Lakshmisha, Jag Pal and Rajkumar Ratankumar Singh. 2016. Development of gender friendly refrigerated fish vending and display unit using solar energy to enhance the keeping quality of fish. *International Conference on EIQASFISH*. FQ-3P, P. 35.
4. Faisal Rashid Sofi, C. V. Raju, I. P. Lakshmisha, K. Dhanapal and Rajkumar Ratankumar Singh. 2016. Synergistic effect of freezing and natural antioxidants on the quality of whole Mackerel (*Rastrelliger Kanagurta*) stored under frozen condition. *International Conference on EIQASFISH*. FQ-4, P15.
5. Raju, C.V., P.J. D'Souza, P. Arun Kumar and I.P. Lakshmisha, 2017. Antimicrobial and antioxidative impact of pomegranate peel extract on extending the shelf life of fish sausage. *International conference on Recent Trends in Agriculture, Biotechnology and Food Processing*, UAS, Hassan, 5th to 7th July, 2017. FTP-34. P.239.
6. Raju, C.V., I.P. Lakshmisha, P. Arun Kumar., Richa Choudhary. 2017. Study on effect of grape seed extract in enhancing the shelf life of fish sausage. *11th IFAF*. 21st to 24th November 2017, AV OR 40, P. 358.
7. Rehana Raj, C.V. Raju., I.P. Lakshmisha, and Jag pal. 2017. Ileal digestibility assay of broiler chicks fed with soybean meal and fish silage as protein supplement in poultry diet. *11th IFAF*. 21st to 24th November 2017, AV OR 47, P. 362.
8. Raju, C.V., C. Aylwin, I.P. Lakshmisha, P. Arun Kumar. 2017. Storage stability of masala coated anchovies (*Stelophorus commersonii*) dried using hybrid solar biomass drier. *11th IFAF*. 21st to 24th November 2017, AV PO 25, P. 376.
9. Raju, C.V., V. N., Deepa, P. Arun Kumar, I.P. Lakshmisha. 2017. Effect of edible coatings on the quality and shelf life of refrigerated Indian mackerel (*Restrelliger Kanagurta*). *11th IFAF*. 21st to 24th November 2017, AV PO 26, P. 377.
10. Raju, C.V., I.P. Lakshmisha, P. Arun Kumar, Amitha, P. Gayatri. 2017. Study on comparative evaluation of icing and solar energy operated refrigerated system

in fish vending cum display unit on the quality of marine fishes during storage.
11th IFAF. 21st to 24th November 2017, SF PO 40, P. 419.

11. Chandra M.V. and Raju C.V. 2015. Effect of filling media on heat penetration and quality characteristics of canned ribbon fish (*Trichiurus lepturus*) in tin free steel cans (TFS). *Frontier Journal of Veterinary and Animal Sciences*, (Vol 4 - issue2).Accepted.