



21st INPRO Dialogue Forum

Deployment of Small Modular Reactor Projects and Technologies in achieving SDGs

Identification of cooperative frameworks suitable for experimenting irradiation as preservative pretreatment to an improved fish fermentation technology developed in Senegal

Prof Michel Bakar DIOP

Lecturer in Food Sciences and Technology
College of Agricultural Sciences,
Aquaculture and Food Technology
Gaston Berger University
Saint-Louis, Senegal (West-Africa)



Michel Bakar DIOP

- Professor of Food sciences and technology
- Promoter of the center for food biotechnology and assistance for competitiveness
- Member of the team for agriculture, food and nutrition of the Senegal national 2021 – 2025 program for cooperation with IAEA in the field of nuclear and radiological security
- Participant to the virtual event in joint Russian federation - IAEA INPRO School for managers and decision-makers in the nuclear sector and government held on November 2021
- Participant of the regional training course in food microbiology testing (2017) hosted by the Department of Radioisotopes and bacteriology in conjunction the National Food Research Center and The Sudan atomic Energy commission sponsored by IAEA
-
- 27 years of experience in teaching in life sciences and hearth (1996 to 2004) and research on food technology (since 2004) across Africa, Europe, India and USA



E-mail: Michel-bakar.diop@ugb.edu.sn

My expectations from the Meeting: Strengthening strategies for the application of irradiation and other nuclear technologies for food safety in West Africa

Table of Contents

1. Senegal, fishery research and Sustainable Development Goals on food security

3. Status of development and deployment of SMRs including associated fuel cycles in Senegal

4. Summary and conclusions

2. Potential role of irradiation to optimize the productivity of fermented fish

1. Senegal, fishery research and Sustainable Development Goals on food security



A west african country with 14 administrative regions

Date of independence: 1960

Population: 18 275 743

Area: 196 712 Km²

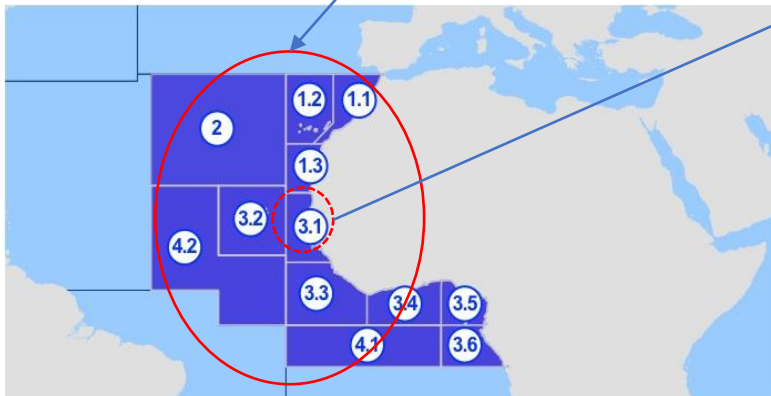
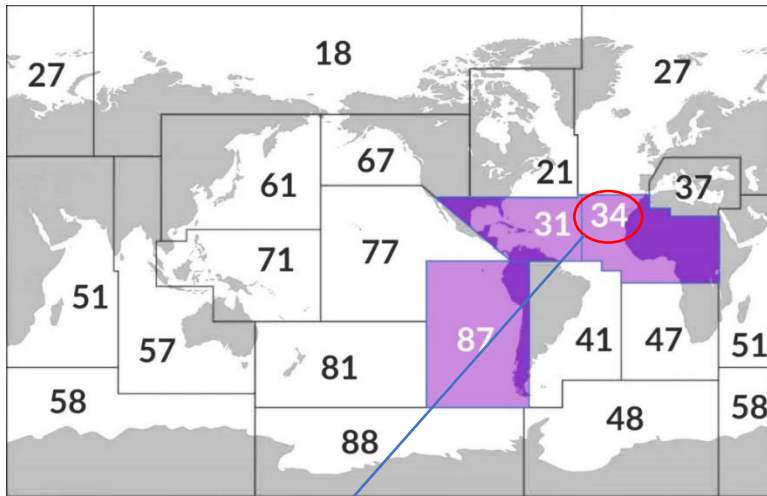
Member of IAEA: 1960

Gross domestic product growth rate: +6,5%

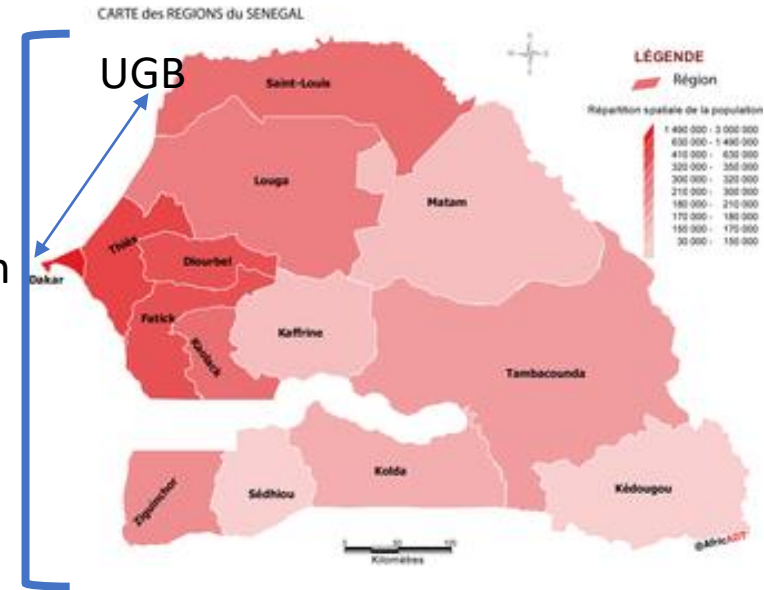
Number of public Universities from 1957 to 2023: 10

1. Senegal, fishery research and Sustainable Development Goals on food security

Potential for marine fishing production in Senegal and SDGs for food security



718 km



1. Senegal, fishery research and Sustainable Development Goals on food security

Marine fishing in Senegal significantly contributes to:

- ✓ employment;
- ✓ Exports (foreign currency inflow);
- ✓ Efforts for food and nutritional security

Marine fish production in Senegal (ANSD 2016 to 2019)

	Means 2016-2019	Contribution (%)
Marine artisanal fishing (T/year)	411 132.75 ± 27 242.8	79.54
Marine industrial fishing (T/year)	105 741.50 ± 12 042.73	20.46
Total (T/year)	516 874.25 ± 30 062. 29	

1. Senegal, fishery research and Sustainable Development Goals on food security

Artisanal marine fish landings (ANSD 2016 to 2019)

	Moy (2016 2019)	Contribution (%)
Fish (T/year)	386 735 ± 25 908	94.18
Crustaceans (T/year)	3 299 ± 673	0.80
Molluscs (T/year)	20 594 ± 2 722	5.02
Total	410 628 ± 27 630	

Traditional fish production has some inherent food safety concerns considering the high susceptibility of seafood to bacterial spoilage

1. Senegal, fishery research and Sustainable Development Goals on food security

Diversity of seafood products exports from Senegal (ANSD 2016 to 2019)

	Means of annual export (tons)
fresh sea fish	220 082.75
crustaceans, molluscs and shellfish	21 678.00
canned fish	4 709.00
dried salted or brine fish	3 143.25
	249 613.00

In 2019, exports of seafood products from Senegal reached 318,485 tons and generated 330.7 billion F CFA **(0.50 billion Euros)**

1. Senegal, fishery research and Sustainable Development Goals on food security

Diversity of indigenous seafood products in Senegal (ANSD 2019)

Local name	Product description	Annual production (tons)
Kethiakh	roasted, salted, and dried <i>Ethmalosa</i> or <i>Sardinella</i>	22 601
Guedj	fermented, salted, and dried fish	5 263
Tambadieng	whole dried <i>Ethmalosa</i>	3 047
Yet	fermented, salted, and dried <i>Cymbium sp</i>	779
Compilation of other products		9 511
Total		41 201

A recent research finding (2012-2022) has been proposed by Gaston Berger University to improve the quality of indigenous seafood products

1. Senegal, fishery research and Sustainable Development Goals on food security

Main potential of Research in Applied Sciences and Technology

Cheikh Anta
DIOP University
(1957)



Gaston Berger University (1990)*

* From 2012 to 2022, development of a new technology of fish fermentation using starters cultures In Gaston Berger University (UGB), which can be associated with **irradiation as preservative pretreatment to enhance the productivity**

1. Senegal, fishery research and Sustainable Development Goals on food security

Improved fermented fish process from the research in UGB

Raw fish product



Fermentation by immersion in local cereal based matrix (4/1) with **selected starter cultures of nisoigenic strains (LMG 33 155 or LMG 331 57) producing Nisin (E 234)**
(25-30°C for 24h)



Salting by NaCl addition at (3%)
(15°C for 6h)



Dehydration in a low-cost
greenhouse solar dryer
(50°C- 65°C for 32h)



Dryed acidified and lighthly salted
seafood products

2. Potential role of irradiation to optimize the productivity of fermented fish

year	Seafood matrix	country	dose	Nuclear reactor	objective
2005	Fermented Fish Paste	University of the Philippines (Nuclear Research Institute), Los Baños	3 kGy and 10 kGy irradiated	Co-60 irradiator	Assesment of the effect of radiation to microorganisms
2023	Fish fillet samples contaminated with <i>Salmonella Typhimurium</i>	Egypt (National Center for Radiation Research and Technology) Cairo,	gamma irradiation treated division at 1KGy, 3 KGy and 5 KGy	Cobalt 60 irradiator	Improve Bacteriological and Physicochemical Quality of Fish

2. Potential role of irradiation to optimize the productivity of fermented fish

Irradiation as pretreatment of raw artisanal handled fish in guedj production



Raw fish product



1 kGy and 10 kGy irradiated of the raw fish products from artisanal handling



Fermentation by immersion in local cereal based matrix (4/1) with selected starter cultures of nisoigenic strains (**LMG 33 155** or **LMG 331 57**) producing Nisin (**E 234**)
(25-30°C for 24h)



Salting by NaCl addition at (3%)
(15°C for 6h)



Dehydration in a low-cost
greenhouse solar dryer
(50°C- 65°C for 32h)



Dryed acidified and lightly salted
seafood products



3. Status of development and deployment of SMRs including associated fuel cycles in Senegal

- **Senegal, member of IAEA since 1960**
- **The country is not yet an International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) Inpro membership**
 - **Inpro membership-based project from Africa, include**
 - **Algeria, 2009**
 - **Egypt, 2011**
 - **Kenya, 2013**
 - **Ghana, 2021**



3. Status of development and deployment of SMRs including associated fuel cycles in Senegal

- Senegal has a **program to build a research reactor**, to develop Energy Mix supply
 - justifying Training of Human Resources in February 2023 with the support of IAEA which contributes to the preparation for the creation
- Other collaboration with IAEA is the participation of the country to:
 - Zoonotic Disease Integrated Action – (ZODIAC) project: IAEA (Coordinator), with FAO and WHO
 - Rays of Hope Project

4. Summary and conclusions

- Senegal is member of IAEA since 1960, that enables participation to different applied project such as (ZODIAC project and Rays of Hope Project)
- Senegal a program to build a research reactor, to develop Energy Mix supply
- A research Microreactors adapted to Co-60 irradiator can be very useful for the localized agrifood systems development to reach Sustainable Development Goals on food security
- How the country can be an International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) membership or collaborate with this project for creating à suitable Microreactors or SMRs that will participate to Energy Mix supply ?

