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FINDING WHAT WORKS

IMPROVING FISH PRESERVATION: COOLING SOLUTION FOR WHOLESALERS

EXPERIMENT RESULTS

Written by Sania Saraswati and Mochamad Dwi Ergianto

January 2021

ABOUT MATA KAIL

The Creative Solutions for Sustainable Consumption and Production of Fish (MATA KAIL) Project, funded by the European Union, was implemented from **March 2018 until February 2021**. It focused on three regencies in East Nusa Tenggara; Lembata, Nagekeo and Sikka. The aim of the project was to **promote sustainable economic growth** and **employment opportunities** of marginalized youth, particularly young women, in the fish-processing sector in Indonesia.

Kopernik supported the implementation of the MATA KAIL project through technology testing interventions. The Cooling Solutions for Wholesalers initiative is one of several experiments conducted to test solutions in improving efficiency in the fisheries sector as well as increasing the incomes of those working in the fish industry in East Nusa Tenggara.

TABLE OF CONTENTS

1. Executive Summary 4
2. Fisheries Sector in Indonesia Overview 5
3. Project Overview 6
   - Context 7
   - Hypothesis 9
   - Experiment Design 10
   - Experiment Flow 11
4. Findings 12
   - Temperature 13
   - Fish Quality 14
   - Chilling Process Cost Projection 15
   - Environmental Benefit 16
5. Conclusion and Recommendations 17

EXECUTIVE SUMMARY

As part of the MATA KAIL project, Kopernik tested a cooling solution for fish wholesalers in preparing fish for export in Sikka Regency, East Nusa Tenggara province (NTT). This cooling solution was introduced as an alternative to the current chilling process of using crushed ice mixed with seawater in Styrofoam boxes - which need to be replaced every six months. We compared the performance of four different set-ups using gel packs, ice, styrofoam box, and insulated containers by measuring seawater temperature, fish quality, chilling process cost, and environmental benefits.

The results showed that:

- A combination of gel packs with ice (cooling solution) kept the chilling temperature below 0 °C for 24 hours regardless of the container type;
- The fish quality was better when fish was preserved using the cooling solution;
- The chilling process using the cooling solution cost 72 percent less as compared to the current method;
- The environmental benefits from the cooling solution were greater than the current method based on the durability, recyclability, electricity and water consumption.

Gel packs and homemade ice space intake comparison

FISHERIES SECTOR IN INDONESIA OVERVIEW

The fisheries sector in Indonesia plays an important role in supporting national food security as approximately 60 percent of the total population lives in coastal areas.[1]

Indonesia marine catches increased by 67 percent from early 2000 to 2018. Being the third largest marine producer in the world, after China and Peru, Indonesia produces 6.71 million tonnes which contributes 8 percent of global marine capture production.[2]

In 2019, fisheries sector in Indonesia contributed around 2.65 percent of the country's total gross domestic products (equal to 30 million USD) - with the exported fish reaching five continents, with Singapore and Malaysia being the biggest fresh fish consumers.[3]

Source: [1] Natural resource aspects of sustainable development in Indonesia. [2] FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. [3] Badan Pusat Statistik, 2019

Fish market in Sikka regency, NTT province

PROJECT OVERVIEW

CONTEXT

One of the most common ways to prepare fish for export is through a chilling process. The chilling process, which involves submerging fish in Chilled Seawater (CSW)[4] (a mixture of seawater and crushed ice), is practiced by wholesalers in Maumere, Sikka regency, NTT.

Fish are typically stored for approximately two days before shipping as the wholesaler must buy fish from several sources to meet minimum quantity required.

When using the current chilling process, the ice melts rapidly, has to be replaced daily- and there is a risk of leaching from the ice that can affect the quality of the fish.[5]

East Nusa Tenggara province

Packing for shipment to the export hub in Makassar

Source: [4] Reyes, D. A. (2015, October). Retrieved from https://www.slideshare.net/donamereyes143/chilling-54266667
[5] FAO Fisheries and Aquaculture Department. (n.d.). 7. IMPROVED FRESH FISH HANDLING METHODS.

CONTEXT

Kopernik's intervention aims to maintain a low temperature during the chilling process prior to shipping fish for export purposes.

Wholesaler activities

Day 1 – Day 3

Purchasing

- Fishermen bring their catch to the wholesaler's warehouse.
- This activity can take up to two to three days until sufficient quantity of fish is collected.

Day 4 – Day 5

Chilling

- Wholesaler uses a chilling process after obtaining fish from the fishermen.
- This takes up to two or three days .

Day 6

Packing

- The wholesaler packs fish according to the export hub requirements.

Day 6

Shipping

- After clearance from the local government, fish are sent to the harbor for shipping to the export hub.
- This activity can take between three to seven days.

HYPOTHESIS

We hypothesize that the cooling solution can preserve fish longer for export purposes, have a lower cost, and be more environmentally-sustainable than the current method,

Control (current method)
Styrofoam box + ice

Key challenges:

- Requires large quantities of ice which increases the operational cost and water usage;
- Regular replacement of Styrofoam box (every six months).

Treatment 3 (cooling solution)
Insulated box + ice gel packs

Key features:

- Less ice required;
- Uses food grade gel packs, which require less space than ice in the freezer.
- Longer container durability.

EXPERIMENT DESIGN

In this experiment, there are four different set-ups. For each one we measured and compared the seawater temperature, fish freshness, operational costs and environmental benefits.

Data collection period: one cycle of chilling process (24 hours)

Experimentation design

	Insulation	Gel Packs	Ice
CONTROL GROUP (Current method)	✗	✗	100%
TREATMENT GROUP 1	✓	✗	100%
TREATMENT GROUP 2	✗	✓	20%
TREATMENT GROUP 3 (Cooling solution)	✓	✓	20%

Indicators

Temperature and fish freshness, measured as Quality Index Method (QIM) by observing: • Appearance/ Texture • Eyes • Gills	Operational cost projections	Environmental benefits: • Water consumption • Lifetime • Recyclability

EXPERIMENT FLOW

The project implementation, including the set-up, design, iteration and data collection, was conducted from August to September 2019.

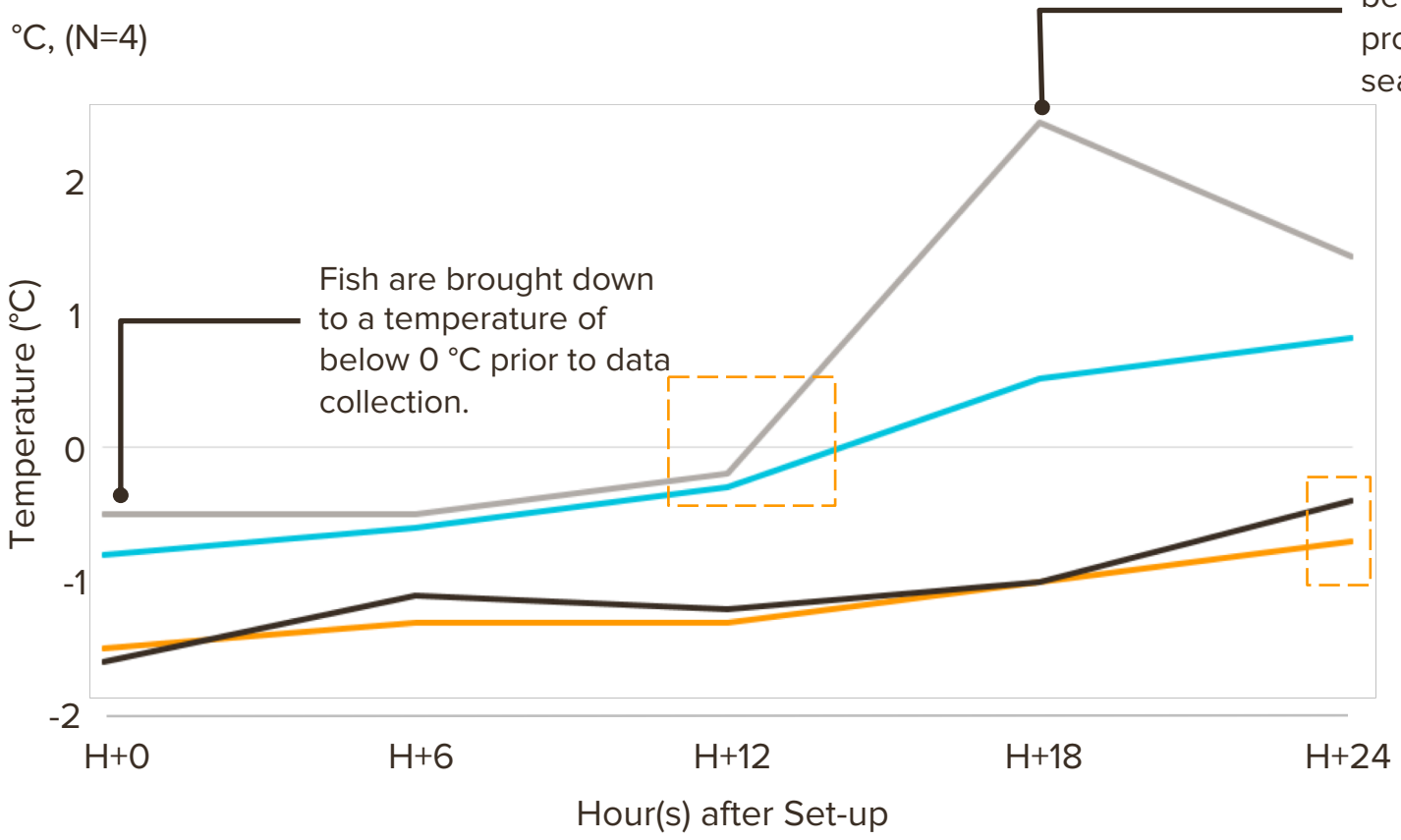
Research and Development	Implementation		Closing
Planning and Research	**Iteration**	**Data Collection**	**Reporting**
			
Activities • Conduct field research • Identify and develop partnership with local partner • Identify chilling process requirements	• Adjust set-up design • Conduct experiment trial	• Collect fish quality and operational cost data	• Evaluate project • Analyze data • Write report
Output Criteria for successful chilling process are identified	Appropriate configurations for the cooling solution is established	Data collected	Comparison of chilling process methods in terms of: (1) temperature, (2) fish quality, (3) operational cost, (4) environmental benefits
Timeline May-Jun ‘19	Jul-Sep ‘19		Oct ‘19-Jan’21

FINDINGS

TEMPERATURE

The findings showed that a combination of ice and gel packs, in Treatment 2 and 3, kept a low temperature for a longer period while the type of container used did not impact temperature levels.

Seawater temperature



Final temperature

1.4 °C (Control, Styrofoam box + ice)

0.8 °C (Treatment 1, insulated box + ice)

Low temperature limit (0 °C)

-0.4 °C (Treatment 2, Styrofoam box + gel packs + ice)

-0.7 °C (Treatment 3, insulated box + gel packs + ice)

FAO recommends to keep fish around -1 °C during chilling process to reduce spoilage.[6]

Source: [6] Graham, J., Johnston, W. A., & Nicholson, F. J. (1993). Ice in fisheries (No. 331). Food and Agriculture Organization. http://www.fao.org/3/T0713E/T0713E01.htm#1.%20Preservative%20effect%20of%20chilling

FISH QUALITY

Better fish quality, reflected by the QIM score, was achieved by the set-up which used gel packs: Treatment 2 and 3.

Quality Index Method (QIM)

QIM is a metric developed to measure fish quality with various parameters by using specific guidelines to assess it over different periods of time[7]. In this experiment, data was collected 24 hours after set-up.

Firmness of the body and its color (bright or pale)

Clarity (clear or cloudy) and shape (normal or sunken)

Appearance / texture

Eyes

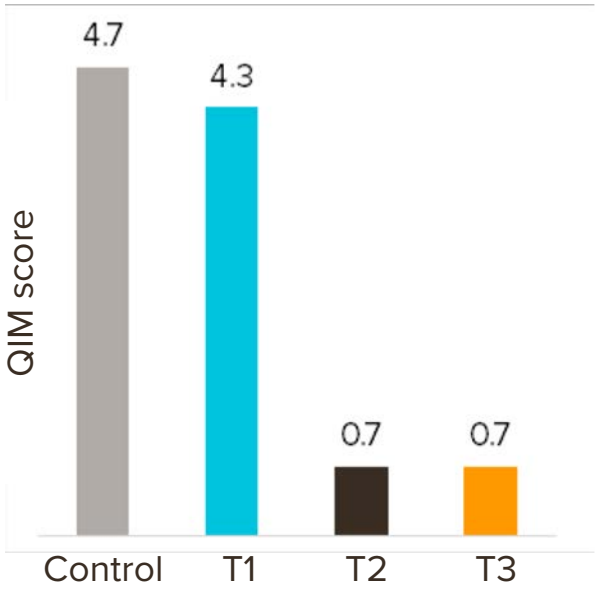
Gills

Thickness and color (red or pale)

0 (Fresh) — **9 (Stale)**

QIM score average

#, (N = 12)

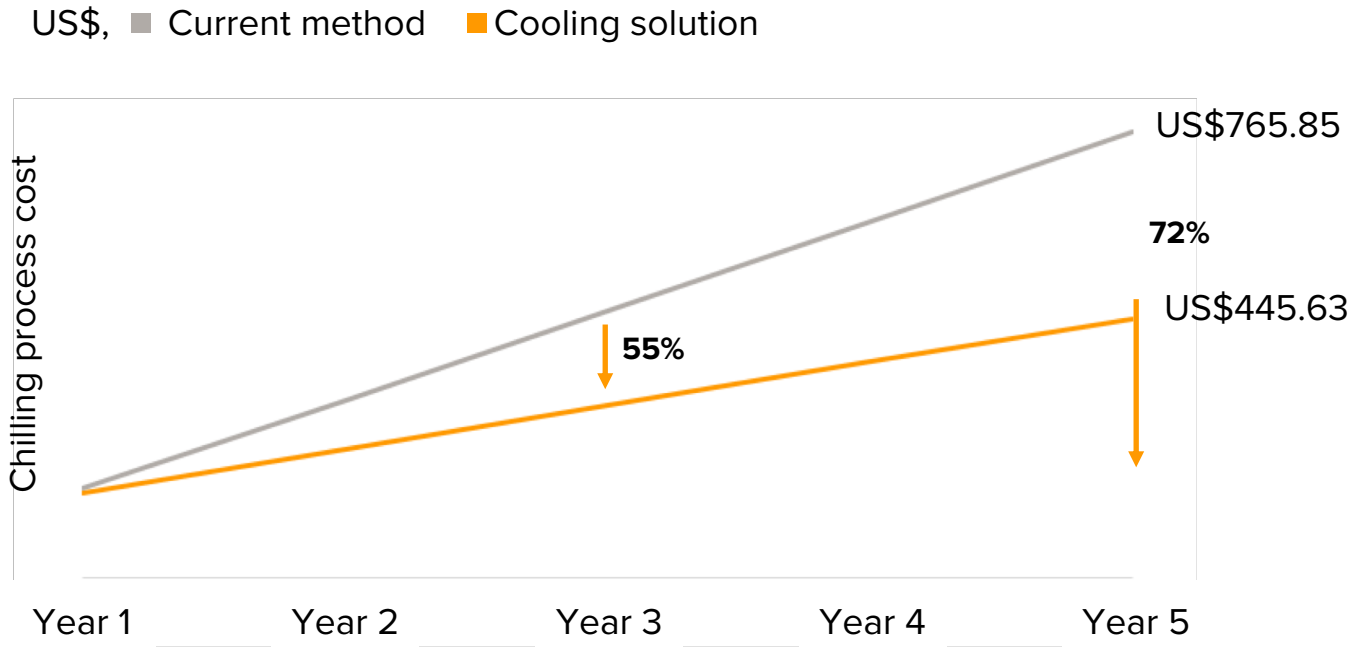


Source: [7] Lougovois, V. P., Kyranas, E. R., & Kyrana, V. R. (2003). Comparison of selected methods of assessing freshness quality and remaining storage life of iced gilthead sea bream (Sparus aurata). Food Research International, 36(6), 551-560.

CHILLING PROCESS COST PROJECTION

The cooling solution has the potential to reduce the average cost of the chilling process by 72 percent over a 5 year period as compared to the current method.

Operational cost accumulation



Assumptions

- The wholesaler already has a freezer and clean water to produce their own ice and freeze the gel packs.
- Gel Packs cost US$1.66 for a 375 ml unit and US$1.81 for the 500 ml unit.
- An insulated container (40 L capacity) costs US$27.10 and lasts for 10 years.
- A styrofoam box (40 L capacity) costs US$4.70 and lasts for six months.
- The current method requires the freezer to be used everyday while the cooling solution requires the freezer to be used at 50% of the time. Thus, the electricity cost is US$12.37 for 30 days (current practice) and US$6.22 for 15 days (cooling solution).per month.
- Price of purchasing fish is excluded.

ENVIRONMENTAL BENEFIT

The cooling solution has the highest environmental benefits based on durability, recyclability, electricity and water consumption.

Key Feature	Control Group (Current method)	Treatment Group 1	Treatment Group 2	Treatment Group 3 (Cooling solution)
Durability Lifespan being one year or more	✓	✓✓	✓✓	✓✓✓
Recyclability Interest and ability for material to be recycled	✓	✓✓	✓	✓✓✓
Electricity Consumption Amount of electricity required	✓	✓	✓✓	✓✓
Water Consumption Amount of water required	✓	✓	✓✓✓	✓✓✓
	4	**6**	**8**	**11**

Styrofoam is generally not recyclable

Description
✓ = Poor
✓✓ = Moderate
✓✓✓ = Good

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CONCLUSION AND RECOMMENDATION

CONCLUSION

We found that the cooling solution maintained better fish quality for export, due to its ability to keep a low temperature for a longer period. Compared to the current method, the cooling solution is projected to save costs during the chilling process by 72 percent over a five year period with more environmental benefits. It is important to note that to optimize gel pack performance, some ice is still required to quickly reach the low temperature required for the chilling process (one-third of the current method amount).

RECOMMENDATIONS

Based on the results of this experiment, Kopernik recommends:

- Explore the establishment of a gel packs hub in NTT to lower the initial investment required; and
- Investigate a passive cooling solution (no electricity requirement) for last mile areas without reliable electricity access.

TESTIMONY

“The cooling solution is a new alternative for chilling fish that uses less water required to produce ice. Although this technology still needs some ice to lower the temperature quickly - the result was really good. Low temperature was maintained as required for the chilling process.”

- Darwin, Director of a wholesale enterprise in Sikka

Kopernik is grateful for the opportunity to work with Darwin. His optimistic, open-minded, and vast knowledge contributed to the success of this project. Darwin passed away in June 2020. Our thoughts and prayers are with his family.

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