

Regulatory compliance and microbiological stability of canned mackerel in tomato sauce marketed in Yaounde, Cameroon

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Abstract

Background: Canned fish constitutes a major and affordable source of animal protein in sub-Saharan Africa. In Cameroon, the urban market is highly dependent on imported canned products. Although commercial sterilization ensures extended shelf life, deficiencies in labeling, packaging integrity, and thermal processing may compromise product safety, particularly under tropical conditions.

Objective: This study assessed labeling conformity, physicochemical quality, packaging integrity, and microbiological stability of canned mackerel in tomato sauce marketed in Yaounde, Cameroon.

Methods: A cross-sectional analytical study was conducted between October 2018 and May 2019. Fifty-six cans (declared net weight: 155 g) representing seven brands ($n = 8$ per brand) were randomly collected from retail markets. Labeling compliance was evaluated according to Codex standards. Net weight, drained weight, pH, titratable acidity, and thermal stability (incubation at 37 °C for 7 days) were determined. Microbiological analyses included total aerobic *mesophilic flora*, *staphylococci*, and *Enterobacteriaceae*. Results were interpreted according to ICMSF criteria. Statistical significance was set at $p < 0.05$.

Results: All brands showed labeling non-compliance, mainly due to absence of storage instructions (100%). Significant net weight deficits were observed in two brands (maximum mean deficit -6.6 g; $p = 0.002$). At 25 °C, no microorganisms were detected (<10 CFU/g). After incubation at 37 °C, 16.1% of samples showed microbial growth (2.08–3.54 log CFU/g), significantly associated with can swelling ($\chi^2 = 6.84$; $p = 0.009$). Two brands exhibited significant pH increases after incubation ($p < 0.01$).

Conclusion: Although commercially sterile at ambient temperature, certain products exhibited reduced safety margins under thermal stress. Strengthened regulatory control and systematic post-market surveillance of imported canned foods are warranted in tropical settings.

Keywords: Canned fish; Mackerel; Labeling compliance; Microbiological stability; Food safety; Cameroon

1. Introduction

Fish and fishery products are essential components of global nutrition, contributing high-quality proteins, essential amino acids, omega-3 fatty acids, vitamins (A, D, B12), and minerals such as iodine and selenium. According to the Food and Agriculture Organization (FAO), fish accounts for nearly 20% of animal protein intake for over 3 billion people

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worldwide [1]. In sub-Saharan Africa, increasing population growth and urbanization have intensified reliance on preserved fish products, particularly canned fish.

Canning is a preservation technology based on thermal sterilization of hermetically sealed containers. The objective is to destroy pathogenic microorganisms and spoilage agents, ensuring commercial sterility. Commercial sterility refers to the absence of viable microorganisms capable of growing under normal non-refrigerated storage conditions [2]. When properly performed, the process guarantees long shelf life without the need for refrigeration.

However, failures may occur at several stages:

- Inadequate thermal processing
- Defective seam formation
- Post-process contamination
- Improper storage or distribution conditions

In tropical climates such as Cameroon, where ambient temperatures frequently exceed 30 °C, thermal abuse during transportation and retail display may reduce product safety margins. Elevated temperatures may accelerate chemical reactions, increase internal can pressure, and stimulate microbial proliferation in cases of marginal processing.

Cameroon's canned fish market is largely dependent on imported products. This context increases the importance of compliance with international standards established by the Codex Alimentarius Commission [3] and microbiological criteria developed by the International Commission on Microbiological Specifications for Foods [2].

Previous studies in African markets have identified labeling deficiencies, weight discrepancies, and microbiological instability in imported canned fish [5,7]. However, limited data are available regarding the Cameroonian market.

The present study aimed to evaluate regulatory compliance, physicochemical quality, packaging integrity, and microbiological stability of canned mackerel in tomato sauce marketed in Yaounde.

2. Materials and Methods

2.1. Study Design and Sampling

A cross-sectional analytical study was conducted from October 2018 to May 2019 in Yaoundé, Cameroon. Fifty-six cans of mackerel in tomato sauce were randomly collected from major retail outlets across different districts.

Seven brands were identified (n = 8 per brand). All declared a net weight of 155 g. Cans were transported to the laboratory under ambient conditions and analyzed before expiry.

2.2. Labeling Compliance

Labels were assessed according to Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985) [3]. The following elements were evaluated:

- Storage instructions
- Importer identification
- Nutritional information
- Durability date
- Country of origin
- Ingredient list

Each label was examined for completeness and conformity.

2.3. Packaging Integrity

Cans were visually inspected for:

- External corrosion
- Deformation

- Swelling (bulging)
- Seam leakage

Inspection was performed at ambient temperature and repeated after incubation at 37 °C for 7 days.

2.4. Physicochemical Analyses

- Net and drained weights were measured using calibrated analytical balances.
- pH was determined using a digital pH meter.
- Titratable acidity was expressed as % citric acid equivalent following titration with NaOH.

2.5. Thermal Stability Test

To simulate thermal stress under tropical conditions, samples were incubated at 37 °C for 7 days. After incubation, visual inspection, pH measurement, and microbiological analyses were repeated.

2.6. Microbiological Analyses

Under aseptic conditions, samples were analyzed for:

- Total aerobic *mesophilic flora*
- *Staphylococci*
- *Enterobacteriaceae*

Counts were expressed as log CFU/g. Detection limit was 10 CFU/g.

Interpretation followed ICMSF recommendations [2].

2.7. Statistical Analysis

Data were analyzed using ANOVA and chi-square tests. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Product Origin

All seven brands (100%) were manufactured in China and imported into Cameroon. No locally produced canned mackerel was identified.

3.2. Labeling Compliance

All brands exhibited at least one non-compliance.

- Absence of storage instructions: 100%
- Incomplete importer identification: 57.1%
- Minor inconsistencies in nutritional labeling format observed in several brands

The absence of storage instructions represents a major deviation from Codex requirements [3].

3.3. Packaging Integrity

At 25 °C:

- 8.9% of cans showed corrosion
- 3.6% showed minor deformation

After incubation at 37 °C

- 10.7% exhibited swelling
- 7.1% showed seam leakage

Swelling was significantly associated with microbial growth ($\chi^2 = 6.84$; $p = 0.009$).

3.4. Net and Drained Weights

- Net weights ranged from 148.4 ± 2.3 g to 154.1 ± 1.6 g.
- Two brands showed significant net weight deficits (up to -6.6 g; $p = 0.002$).
- Drained weights ranged between 92.3 ± 3.4 g and 101.6 ± 2.8 g.

3.5. Physicochemical Parameters

At 25 °C

- pH ranged from 4.08 ± 0.09 to 4.42 ± 0.12
- Titratable acidity ranged from 0.38% to 0.46% citric acid

After incubation

- Two brands showed significant pH increases (up to 4.71 ± 0.18 ; $p < 0.01$)
- Titratable acidity remained relatively stable

3.6. Microbiological Quality

At ambient temperature

- No detectable microorganisms (<10 CFU/g)

After incubation

- 16.1% showed total aerobic counts (2.08–3.54 log CFU/g)
- *Staphylococci* detected in 8.9%
- *Enterobacteriaceae* detected in 7.1%

Maximum count: 3.5 log CFU/g.

4. Discussion

This study demonstrates that although canned mackerel marketed in Yaounde met criteria for commercial sterility at ambient temperature [2], significant regulatory and technological deficiencies were identified.

The exclusive origin of sampled products from a single exporting country highlights the strong dependence of the local market on imports. Such concentration may increase exposure to systemic quality deficiencies if regulatory control at entry points is not sufficiently rigorous.

The universal absence of storage instructions represents a major compliance failure under Codex standards [3]. In tropical environments, elevated temperatures may accelerate microbiological and physicochemical alterations [5].

Observed can swelling and microbial growth after incubation suggest marginal thermal processing or post-process contamination. Similar findings have been reported in imported canned fish in other African contexts [5,7].

While microbial loads remained moderate, their detection after thermal stress indicates reduced safety margins. Such conditions may become critical if distribution systems expose products to prolonged high temperatures [4].

Weight deficits further indicate insufficient quality control during production.

Overall, findings highlight the need for strengthened import inspection, systematic post-market surveillance and enforcement of international food safety standards [2,3].

5. Conclusion

Canned mackerel marketed in Yaounde met criteria for commercial sterility at ambient temperature but exhibited labeling non-compliance, weight deviations, and microbiological instability under thermal stress.

Enhanced regulatory oversight of imported canned foods is essential to safeguard public health in tropical environments.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no financial, institutional, or personal conflicts of interest that could have influenced the results or interpretation of the data presented in this study.

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Statement of ethical approval

All analyses were performed in accordance with good laboratory practices and principles of scientific integrity.

Commercial brands were anonymized in the presentation and interpretation of the results to ensure commercial confidentiality and to prevent unjustified stigmatization. The collected data were used solely for scientific research and public health purposes.

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