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Nutritional Value and Food Safety of Processed Anchovies at Two Fish Markets in Dar es Salaam, Tanzania

—Findings from Focus Group Discussions—

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Key Findings

- There is a sharp contrast in processing practices in Kunduchi and Ferry fish markets. In Kunduchi, anchovy processing is mostly geared toward distant markets, with a focus on boiling and sun-drying methods that support longer shelf life and easier transport. In contrast, processing in Ferry centers around frying for immediate consumption within nearby communities. These differences shape the infrastructure and regulatory approaches found in each market.
- Processing methods are largely dictated by practical and economic considerations. Boiling is associated with greater hygiene and nutritional value, though it requires significant investment in equipment, labor, and fuel, making it a domain dominated by men. Frying is less capital-intensive, suitable for small daily operations and better aligned to ensure a daily cash flow. As a result, it is more common among women in Kunduchi. However, in Ferry, women's participation in frying is limited due to a co-ownership model for stoves that restricts their access, reinforcing male dominance in this activity.
- Consumer preferences are mostly driven by taste, price, and availability. Fried anchovies are popular due to their flavor and convenience, especially in Ferry. Boiled products are increasingly favored by health-conscious consumers. However, sun-dried anchovies face fluctuating demand, especially during the rainy season when concerns about hygiene are heightened.
- Perceptions of nutrition and food safety vary by processing method. Boiled anchovies are generally considered the most nutritious, as the process reduces microbial risks and often includes salt. Sun-dried anchovies are nutrient-dense but vulnerable to contamination under poor handling conditions. Fried anchovies, despite their popularity, are viewed as less healthy due to the repeated use of cooking oil, which can introduce chemical hazards. Across all methods, risks related to physical contaminants (e.g., sand), chemical residues, and microbial growth are present, particularly in settings where hygiene practices are weak.
- Seasonal variation plays a large role in processing intensity and food safety outcomes. During the rainy season (*bamvua*), large fish catches lead to a spike in processing. However, frequent rains complicate sun-drying, increasing the risk of contamination. Consumer complaints often emerge around odor and spoilage during this period. The dry season (*kaskazi*) presents more favorable drying conditions but sees fewer catches, which reduces boiling activity. Frying is the most consistent method throughout the year, adaptable to both high and low supply periods.
- There are significant environmental and health implications of energy use in processing. Most processors rely on firewood for boiling and sometimes frying, contributing to deforestation and respiratory health risks. While Ferry has made strides in promoting gas as a cleaner alternative—especially for frying—its uptake remains limited due to cost. In Kunduchi, the transition to gas is still at an early stage. Although sun-drying has minimal environmental impact, it remains vulnerable to weather disruptions.

Key Findings (continued)

- Gender disparities are evident. In Kunduchi, women dominate frying but face significant barriers in accessing boiling facilities due to high startup costs, labor demands, and institutional limitations. Notably, only one woman in Kunduchi owns a boiling setup and hires men to operate it. In Ferry, the situation is reversed—frying is male-dominated due to a non-transferable and non-inheritable stove ownership model sanctioned by local authorities. These systemic constraints limit women's economic mobility and participation.
- Regulatory frameworks also vary widely between the two sites. Kunduchi operates with minimal formal oversight. Processing licenses are not required, and the only regulations in place are loosely enforced market bylaws, with fines levied for packaging violations. In Ferry, regulation is more structured, including mandatory annual licenses for processors and daily hygiene inspections. Nevertheless, enforcement is inconsistent, and record-keeping remains informal across both locations.
- Hygiene and infrastructure gaps pose a serious threat to food safety in both sites. Access to clean water, designated processing sheds, and proper storage facilities is limited. While some processors adopt good practices—such as use of gloves and routine cleaning—most operate in cramped, makeshift environments that compromise food hygiene. Processors are generally aware of these risks but lack the financial means or institutional support to address them.
- Across both markets, there is a strong expressed need for targeted support. Processors request technical training, access to equipment, and improved infrastructure. Women, in particular, highlight the need for credit facilities, fair licensing procedures, and access to modern technologies such as solar dryers. There is also a clear expectation for increased involvement by government agencies and NGOs.
- In light of these challenges, a set of actionable recommendations emerges. Infrastructure investments are urgently needed to improve access to clean water, drying racks, and processing sheds. Cleaner energy alternatives, such as subsidized gas, should be promoted—especially in Kunduchi—to reduce environmental and health impacts. Policies on stove ownership in Ferry should be revised to allow women full participation, including the ability to inherit and transfer ownership.
- Kunduchi's regulatory environment should be strengthened with licensing requirements, regular inspections, and standardized record-keeping practices. Consumer awareness campaigns should highlight the dangers of reused oil and the health benefits of safe processing.

Introduction

Anchovy fishing and processing represent vital economic and food security activities in coastal Tanzania, particularly in local fish markets such as Kunduchi and Ferry, found in Dar es Salaam. This brief presents a comparative analysis of anchovy processing practices in these two locations, based on findings from focus group discussions held with local processors. It examines the most common processing techniques, the methods processors choose, the factors influencing their choices (including energy use, environmental impacts, seasonal patterns, consumer preferences, and gender dynamics), the perceived effects of processing on nutrition and safety considerations,

and support needs. The aim is to inform policy and development efforts that enhance nutrition, safety, and equity in small-scale fisheries.

Method

[Insert summary of the focus groups, ~ 2 paragraphs)

Results

Common processing methods for anchovies

Anchovy processing in Kunduchi and Ferry fish markets is characterized by the use of three primary methods: direct sun-drying (*kuanika*), boiling in salted water followed by sun-drying (kuchemsha na kuanika), and frying (*kukaanga*). In Ferry, frying is the most prevalent method, particularly targeting local consumers who favor ready-to-eat products. To minimize costs, Ferry processors commonly mix palm oil (*mawese*) with more expensive vegetable oil. This oil mixture is reused multiple times until its viscosity degrades to the point that it can ignite, posing chemical and health risks. While most consumers accept reused oil for lower prices, some bring their own oil or insist on fresh oil, raising the cost of the fried anchovies. Boiling is used less frequently at Ferry due to limited space, primarily for extending shelf life and improving quality during high anchovy catch. Sun-drying, although rare, is reserved for by-products or anchovy meal used as animal feed. At Kunduchi, boiling and sun-drying are the predominant techniques. Anchovies are boiled in salted water to enhance preservation and flavor before being dried on a chanja or nets. Sun-drying alone, without boiling, is specifically employed for producing animal feed. Frying is a secondary method, largely undertaken by women who serve local consumer markets with immediate, ready-to-eat products.

Factors influencing choice of processing method

Environmental concerns

Energy sources for processing vary across methods and markets. Frying at Ferry relies solely on gas, as mandated by local health and safety regulations, whereas Kunduchi processors still use charcoal, firewood, and, increasingly, gas as well. Boiling in both locations primarily uses firewood, though gas is occasionally used when available. Sun-drying, which relies on solar energy, is the most environmentally sustainable but highly weather-dependent. The use of firewood presents serious environmental and health concerns, including deforestation, respiratory problems, and heat buildup. Meanwhile, gas, although cleaner, remains expensive and can be potentially hazardous if mishandled.

Seasonal variation

Seasonality plays a vital role in anchovy processing patterns at both Ferry and Kunduchi fish markets, affecting method selection, operational intensity, and labour dynamics. During the *Matilai ya Kusi* season (March to May) in Kunduchi, coastal waters are more productive, leading to higher anchovy landings. This period sees a significant rise in boiling and sun-drying, especially boiling, as processors seek to preserve large quantities of fish with an extended shelf life suitable for distant markets. However, sun-drying becomes difficult due to frequent rains and high humidity, which hamper proper drying and increase the risk of contamination from dust, flies, and moisture.

Consequently, consumers often raise concerns about the odour and hygiene of sun-dried products during this season, limiting their market appeal. During the Kaskazi season (December to February), Kunduchi experiences dry and sunny weather but with reduced fish catches. As a result, boiling activities decline because smaller volumes are less cost-effective, considering the high costs of firewood and labour. Conversely, sun-drying becomes more feasible due to favourable drying conditions, while frying continues consistently throughout the year, being adaptable to both low and high supplies and catering to local daily needs.

At Ferry, similarly, the Kusi season (June to September) is the high season, marked by cool, productive waters that result in an abundance of anchovy catches. This abundance intensifies processing activities, particularly frying, which dominates the market due to its quick turnover and alignment with local consumer preferences. Boiling is limited to a single processing unit at Ferry, which operates primarily during this peak season to prepare anchovies for long-distance markets, such as those in Congo and the upcountry regions. Despite its potential nutritional benefits, the limited infrastructure for boiling restricts its wider adoption. The increased supply during the Kusi season also leads to processor fatigue due to extended frying hours and high daily demand. During the Kaskazi season, Ferry faces hot and dry conditions, accompanied by significantly reduced fish availability. As a result, boiling at the single unit decreases, given that small catches do not justify the cost and effort required. Frying remains relatively stable, as it allows for the processing of small batches and fulfils consistent local demand. Sun-drying becomes more practical in this dry season, but it remains a secondary method mainly used for producing anchovy meal for animal feed. Seasonal fluctuations in fish supply at both sites thus dictate the choice and scale of processing methods. While Kunduchi adapts its methods to meet both local and external demand with a stronger emphasis on boiling and sun-drying, Ferry relies primarily on frying with limited capacity for diversification.

Socio-economic and cultural factors

Processors select their methods based on various factors. Socio-economic aspects are crucial; for instance, frying demands less capital than boiling, making it more accessible to many. Cultural influences are minimal, as choices are mainly driven by market incentives. Limited access to gas stoves and drying racks further restricts technological options. Market demand heavily influences processing choices — fried anchovies are increasingly preferred by short-distance buyers for their flavour and convenience, while boiled products are chosen for their durability and cleanliness, suitable for long-distance or external markets. Technological and resource constraints, such as limited availability of boiling drums, gas stoves, drying nets, and infrastructure, particularly affect women and small-scale processors. Socio-economic status also impacts method choice; frying is more accessible to women due to lower capital and space needs, while boiling requires more effort, firewood, and physical endurance, often making it more suitable for men. Overall, cultural traditions have a minor role, with market forces mainly shaping the processing methods.

Consumer perceptions

Consumer preferences differ across markets. Fried anchovies are valued for their flavour and convenience, though concerns about oil reuse persist. At Ferry, customer demand for fresh oil raises product costs. Boiled anchovies are lauded for their hygienic appearance, durability, and assumed nutritional value. Sun-dried products receive mixed reviews, especially during rainy seasons, due to odour and hygiene issues. Nutritional value is not a primary concern for most consumers; rather, affordability, taste, and portion size influence their choices.

Consumers have varied opinions based on taste, safety, and nutritional beliefs:

- Fried anchovies are enjoyed for their flavour and readiness to consume but raise worries about oil reuse.
- Boiled anchovies are praised for their hygiene and shelf life.
- Sun-dried anchovies, particularly during the rainy season, garner negative feedback due to subpar drying conditions and potential contamination.
- At Ferry, some consumers bring their own oil or insist on fresh oil, leading processors to charge higher prices. This trend highlights the increasing consumer awareness of food safety.

Nutritional and safety considerations

In terms of nutrition and safety, boiled anchovies are regarded as most beneficial, mainly because of the addition of salt during processing. Sun-dried anchovies retain nutrients but are vulnerable to contamination from improper drying conditions. Fried anchovies are often seen as less healthy, especially when oil is reused multiple times. Chemical risks from prolonged oil use at Ferry are particularly concerning. Boiling and frying are preferred methods because they apply heat treatment, which helps eliminate pathogens, whereas sun-drying, if poorly managed, can pose risks of microbial, chemical, and physical contamination. Processors and consumers believe boiled anchovies are the most nutritious due to the added salt, which is thought to boost mineral content. Sun-dried products are considered to retain most nutrients because of minimal processing but can be vulnerable to contamination if not handled properly. Fried anchovies are viewed as less healthy because high heat and reused oil degrade nutrients. Safety risks include microbial growth in poorly dried fish, physical contamination (e.g., sand), and chemical hazards from reusing oil. Boiling and frying effectively control pathogens through heat, while sun-drying requires strict hygiene practices to ensure safety.

Best practices for hygiene and safety

Maintaining hygiene and safety is essential but often challenged by limited infrastructure. Risks include exposure to flies, dust, and unclean surfaces. The use of non-food-grade containers, such as plastic, in high heat, exacerbates these risks. Processors mitigate these hazards by using gloves, boots, aprons, and clean water, and by regularly cleaning utensils and processing surfaces. Drying racks are used to avoid ground contact. However, the lack of dedicated sheds, drying structures, and reliable access to clean water calls for infrastructure upgrades. Infrastructure improvements such as processing sheds, clean water access, and gas storage areas would significantly enhance hygiene.

Gender differences in processing

Gender dynamics are also deeply embedded in these processing systems. In Kunduchi, women dominate frying, while boiling is largely performed by men due to its labor and equipment intensity. Only one woman owns a boiling facility in Kunduchi, and she hires men to operate it. At Ferry, frying is almost entirely a male domain, supported by a stove ownership structure in which units are co-owned by two men, non-transferable, and non-inheritable. Women encounter several significant barriers in this sector, which hinder their entry and progression. Addressing these gender-specific

challenges through policy reforms and supportive interventions could pave the way for greater participation and economic gains.

Challenges faced by women include:

- Limited access to capital and equipment needed for boiling processes
- Criticism and penalties from male colleagues or market leaders
- Physical strain associated with high-heat procedures
- Exclusion from stove ownership structures in Ferry. These issues collectively constrain women's ability to expand or diversify their processing activities.

Regulations and compliance

The regulatory environments in Kunduchi and Ferry markets differ significantly. In Kunduchi, formal oversight is minimal. While transporters are required to have licenses, processors largely operate without formal regulation, except for local bylaws that govern packaging standards. Non-compliance with these bylaws may result in fines of up to TZS 50,000. Record-keeping in Kunduchi is generally informal and often relies on memory rather than written documentation. In contrast, the Ferry market maintains a stricter regulatory framework. Processors are required to obtain annual licenses at a cost of TZS 12,500, and daily hygiene inspections are conducted routinely. Moreover, structured ownership of processing stoves is enforced. Record-keeping among processors, particularly boilers, is more systematic, with logs maintained for input costs, buyer details, and distribution. However, fryers at Ferry still rely on informal methods, such as verbal records and memory. Despite these regulatory differences, neither market conducts routine food safety inspections. Customer complaints are rare in both locations and usually relate to pricing or quality fluctuations during the rainy season.

Support needs

Support needs voiced by processors span technical, financial, and institutional assistance. Training on food safety and modern drying techniques is needed, along with access to loans for purchasing drying machines, gas stoves, and hygiene gear. Processors request stronger government involvement to improve infrastructure and conduct regular inspections. NGOs are encouraged to provide nutrition education, materials, and hands-on training to raise safety and quality standards.

Conclusion

Anchovy processing systems in Ferry and Kunduchi reflect a mix of shared challenges and local variations in technique, gender roles, and operational constraints. While both systems are remarkably adaptive to seasonal and market dynamics, improvements in regulation, infrastructure, and gender equity are essential to unlocking their full nutritional and economic potential.

Key recommendations include enhancing access to capital for women and small-scale processors, revising stove ownership policies, investing in essential infrastructure, training processors in hygiene and business skills, promoting modern drying technologies, enforcing market-based hygiene standards, establishing traceability systems, and raising consumer awareness about nutrition and food safety.