



Market women's skills, constraints, and agency in supplying affordable, safe, and high-quality fish in Ghana

Ragnhild Overå¹ · Amy Atter² · Samuel Amponsah³ · Marian Kjellevold⁴

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Abstract

In Ghana, the role of female informal traders (“market women”) in making low-cost smoked and dried fish available in urban and rural marketplaces is the key to explaining the high consumption of fish in the country. However, market women’s contribution to food security and nutrition (FSN), as well as to fish quality and safety is underrated and poorly understood. Fish marketing requires proficient distribution and preservation skills, economic and sociocultural competence, and a high degree of mobility. Fish traders face numerous constraints related to fish supplies, credit access, hygiene, storage facilities, transport, and market governance, all of which affect their incomes and may affect the quality and safety of fish. The article, which is based on semi-structured interviews with fish traders and fish consumers in coastal and inland markets in Ghana, documents how traders operate and exhibit agency to deal with constraints by activating a range of skills in their profit-making and their fish quality and safety enhancement strategies. The authors argue that policies grounded in knowledge about fish traders’ activities, skills, and working conditions, with budgets that prioritize investment in public infrastructure that caters for market women’s professional and personal needs, can further enhance their ability to supply affordable, safe, and high-quality fish to Ghana’s population.

Keywords Fish markets · Female informal traders · Agency · Fish safety · Food security and nutrition · Ghana

Introduction

In Ghana, the skilful and laborious fish preservation and distribution efforts by market women¹ enable consumers all over the country to access affordable fish (Nunoo et al. 2015). However, when operating in a market environment characterized by poor infrastructure and sanitation, it can be challenging for fish traders to maintain high standard of fish quality, which thus affects their income-generating potential, as well as fish safety. In this study, we document female informal traders’ often underrated fish marketing and

quality enhancing skills, and we discuss how policies can build on these in order to sustain the contribution of fish to food security and nutrition (FSN) in Ghana.

There is a great demand for fish among Ghana’s 30.8 million inhabitants (Ghana Statistical Service 2021). The annual per capita fish consumption is 28 kg (FAO 2016), which is substantially higher than in most other countries in Africa (9.9 kg per year on average) and elsewhere in the world (20.3 kg per year) (FAO 2020: 70). Small and low-cost pelagic fish species, such as anchovies, sardinellas, and mackerel are widely consumed (Nunoo et al. 2015; Hasselberg et al. 2020a; Onumah et al. 2020). Small fish tend to be the cheapest type of animal source foods (ASF) in the market and are mostly consumed whole, with the bones, head, and viscera providing micronutrients that are essential for the nutrition and health of low-income consumers and vulnerable groups such as infants, pregnant women, and lactating mothers (HLPE 2014). Traditionally processed small fish, such as the smoked and/or sun-dried anchovies which in Ghana are popularly known as “Keta school boys” have a long shelf-life and are ideal lightweight products for long-distance distribution in

¹ The term “market women” refers to female informal traders.

✉ Ragnhild Overå
ragnhild.overa@uib.no

¹ Department of Geography, University of Bergen, Bergen, Norway

² CSIR-Food Research Institute, Accra, Ghana

³ Department of Fisheries and Water Resources, University of Energy and Natural Resources, Sunyani, Ghana

⁴ Institute of Marine Research, Bergen, Norway

areas with poor refrigeration facilities. Their value chains extend to Northern Ghana and beyond into neighboring countries, reaching consumers in large cities and remote villages (Nunoo et al. 2015; Ayilu et al. 2016). Small fish are easy to market through the practice of breaking bulk (i.e., into small volume units), making it attractive for consumer groups who can only afford to purchase small quantities of ASF to improve their diets.

The fish consumed in Ghana is produced by small-scale fisheries (70%), semi-industrial and industrial fisheries, and aquaculture industries (Nunoo et al. 2014). To meet domestic demand, approximately the same quantity of fish is imported into the country (mainly mackerels and sardinellas) as the recorded landed catches (FAO 2016; Sumberg et al. 2016; Onumah et al. 2020). Export is limited and is mainly in the form of tuna for canning. Recent estimates of fish availability in Ghana indicate that the per capita consumption could be as high as 35 kg per year (Hasselberg et al. 2020a) if unrecorded fish are included, particularly fish from inland capture fisheries and illegal transshipments of “saiko” fish from industrial vessels (Overå 2005; Nunoo et al. 2009; Environmental Justice Foundation and Hen Mpoano 2019).

Irrespective of the supply source, small- and large-scale traders transport locally processed fish to coastal and inland marketplaces where it is sold either retail to consumers or wholesale to traders who then take the fish to more remote markets. The result is that 95% of small pelagic fish landings are for human consumption (Nunoo et al. 2015) and 75% of Ghana’s total fish production is consumed domestically (Dovlo et al. 2016). Fish trade not only contributes directly to FSN by facilitating fish access to consumers, but also contributes indirectly when the incomes generated by fish traders are used to improve the FSN of their households (Kawarazuka and Béné 2010). This study, which is part of the SmallFishFood project (<http://www.smallfishfood.org/>), aims to highlight that in terms of utilizing fish resources for the purpose of maximizing FSN, Ghana’s domestic fish distribution system is highly efficient in both serving low-income consumer demand and providing livelihood opportunities.

Extensive research has been done on Ghanaian fisheries’ technological development (e.g., Vercrujse 1984; Hernæs 1991; Overå 2011) and management (e.g., Atta-Mills et al. 2004; Nunoo et al. 2014; Asiedu et al. 2021). Policies and interventions have mainly focused on the fishing itself, while the processing, distribution, and marketing of the fish have received less attention. This is a paradox considering that of the estimated 1.9 million people in fisheries-based livelihoods, only one-tenth are fishers: in 2016, there were 107,518 fishers in the marine canoe fisheries, most of whom

were men, while most women worked in the post-harvest sector (Dovlo et al. 2016).²

Food trade is largely conceptualized as “women’s work” according to local gender norms in Ghana (Clark 1994; Overå 2007). Historically, women’s role as food traders is well documented (e.g., Cruikshank 1853; Daniell 1856). The predominance of women in fish trade was documented already in 1602, when the Dutch trader Pieter de Marees wrote the following in his account of the Gold Kingdom of Guinea: “fish, which their husbands have gotten in the sea, whereof the women buy much, and carried them to other towns within the land, to get some profit of them, so that the fish which is taken in the sea, is carried at least an hundred miles up into the land, for a great present, although many times it stinks like carrion, and hath a thousand maggots creeping in it” (quoted in Overå 1993: 115). Apart from vividly describing the fish quality issue, which we will also discuss shortly, he articulated how important women were for the fishing economy. This is still the case, as documented in a relatively rich body of literature (e.g., Vercrujse 1984; Odotei 1992; Overå 1993, 1998, 2005; Britwum 2009; Nunoo et al. 2015; Ameyaw et al. 2020).

In this study, we take the opposite perspective of what Belton et al. (2022) call a “productivist” focus on fisheries and instead pay attention to the crucial role for FSN of the trader segment in the supply chain. This emphasis resonates well with the current shift in discourse from a dominant focus on fish as either an economic resource from which to profit or as stocks in need of conservation, to valuing fish primarily as a micronutrient-dense resource to be sustainably used as food (e.g., Cohen et al. 2019; Bennett et al. 2021; Golden et al. 2021). In this increasingly influential discourse of seeing fisheries as food systems (Simman et al. 2021), the significance of the skills and labor of small-scale traders for low-income consumers’ access to safe and high-quality aquatic foods, should take center stage. In our marketplace and market woman-centered FSN perspective, we analyze (1) how fish sold in the market arrived there (i.e., traders’ role in fish availability, access, and stability) and (2) market women’s practices for enhancing fish safety and quality (i.e., traders’ role in fish utilization) (HLPE 2020: 10).

The recognition of agency as a key aspect of FSN (HLPE 2020) is relevant to our understanding of the role of fish traders in the food system. Firstly, traders’ own agency involves their capacity to sustain a livelihood and take actions to improve the well-being of themselves, their households, and their communities, and to have a voice in policy making. Secondly, traders contribute to shaping the agency of fish consumers by enabling

² Though not well documented in the inland fisheries, the proportion and gender division of labor is similar in the harvesting/post-harvest sector.

their capacity to access and choose affordable and culturally acceptable ASF that are crucial for their health.

Agency refers to the capacity of individuals within the constraining or enabling structures—the institutional arrangements that constitute and govern their livelihood strategies—to act independently and to make free choices (Kabeer 2021). Institutions can, for example, be gender norms that structure gender division of labor, access to and control over resources, and decision-making power. It could be argued that fish traders try to exercise power within the limitations they encounter in society by activating their available “power resources” (Svarstad et al. 2018). Power resources can be conceptualized as social, economic, material, discursive, or symbolic forms of capital (Bourdieu 1977) that can be acquired, accumulated, and converted into one another, for example, by gaining economic or political power through kinship relations. The possibility to activate such resources is not equally distributed, as different groups of people are positioned within their social hierarchies by intersecting identities such as gender, age, class, and ethnicity. Thus, positionalities influence traders’ capabilities, reflecting the “interaction between the resources at their disposal and their ability to translate these resources into valued goals” (Kabeer 2021: 99).

The literature on Ghanaian market women contains many examples of how social networks and cultural capital acquired through experience in the “marketplace system” (Clark 1994) enables agency despite of operating within an uncertain economic environment with poor infrastructure. Trade relations are socially embedded and largely depend on interpersonal trust. Consequently, a trader’s greatest asset is to be known as trustworthy with regard to debt repayment and product quality, a reputation that is established and tested through numerous interactions and transactions over time (Chalfin 2000; Overå 2006). Should their fish products be damaged, delayed, stolen, or “go bad,” such traders are not covered by insurance. Therefore, the traders activate their experience-based tacit knowledge and collegial networks to assess and minimize risk, for example, by making sure they have a broad base of options (Chalfin 2000: 995). Engaging with numerous personal trading partners enables traders to strategize in order to find solutions to supply shortages, market gluts, vehicle breakdowns, and many other challenges.

Clark (1994; 2000) has illuminated how the ability of traders in perishable foods to quickly and flexibly respond to obstacles and opportunities is crucial for FSN. The traders have the capacity to adjust to seasonal fluctuations in supplies and to unpredictable economic or political shocks that lead to food shortages. Fish traders in Ghana typically demonstrate such capacities by exchanging market information by mobile phone with partners in their extensive trade networks, whereby they adapt fish supplies to local market demand (Overå 2006; Salia et al. 2011). Such strategies enhance the resilience of the marketplace-based food system and thereby the stability of food supplies (Clark 2000).

Societal structures such as local gender norms and legislation regarding informal economic activity constrain traders’ agency (Overå 2007). Despite being well-organized through associations with market leaders—*ahemaa*—female traders’ economic and FSN importance is not translated into political influence. Many traders are illiterate, and their many practical qualifications are unappreciated. In other words, the social and cultural capital that women acquire in the marketplace cannot easily be converted into political power. Such barriers constrain agency of fish traders and limit their inclusion in policy processes seeking to improve market infrastructure and fish quality. The non-inclusion of female traders’ interests and needs in policymaking runs the risk of “missing the target of creating sustainable livelihoods based on marine resources” (Ameyaw et al. 2020: 1).

This study explores traders’ skills and practices with regard to enhancing fish quality and safety, and we emphasize that these must be understood and assessed in the context of the economic, sociocultural, and infrastructural constraints described above. The concern for fish quality and safety (Teklemariam et al. 2015) emanates from the highly perishable nature of fish, in addition to several environmental factors (e.g., handling practices, and storage conditions) (Dowlati et al. 2013). Different traditional processing methods (smoking, drying, salting, frying) are used to enhance the safety and quality of fish. However, it has been reported that some traditionally processed fish have been contaminated (Arthur and Osei-Somuah 2004; Kwenin et al. 2013). For instance, smoking with traditional kilns using wood fuel produces high polycyclic aromatic hydrocarbon (PAH) levels in the fish (Bomfeh et al. 2019), which when consumed frequently can cause cancer (Asamoah et al. 2020). Also, some fish are dried in unhygienic places such as on bare ground, and histamines can form in the fish due to insufficient temperature and time use during drying and storage. During long storage, the fish are sometimes smoked or dried a second time to extend its shelf life. Different contaminants have been reported in some fish species, including anchovies, which have raised concerns about public health in Ghana (Mensah et al. 2002; Kombat et al. 2013; Kwenin et al. 2013; Paudyal et al. 2017; Hasselberg et al. 2020b).

We argue that the starting point for policies must be an appreciation of the importance of the informal fish marketing system for FSN and that any measures to improve fish quality and safety must be grounded in knowledge about fish traders’ activities, skills, and working conditions.

Methods

To capture the variation in fish markets and traders’ experiences, we selected 11 large and centrally located marketplaces in six cities (Fig. 1), which represent important

coastal, inland, and northern fish marketing hubs. In these markets, we conducted a survey with 92 fish traders by using a semi-structured questionnaire to map their socio-economic background, sources of fish supplies, fish species traded, fish products' processed form, storage methods, and challenges.

We conducted the market survey during three 2-week periods, starting in October 2017 in Accra (Makola, Madina, Agbobloshie, Adabraka, and Mamprobi/Tuesday Markets) and Tema (Tema and Ashaiman Markets), continuing in February 2018 in Kumasi (Kumasi Central and Asafo Markets) and Techiman (Techiman Market), and finally in November 2018 in Tamale (Tamale and Central Markets) and Bolgatanga (Old and New Markets). Wholesale and retail of marine and inland fish species occur in all the selected markets, though some of the markets specialize more in wholesale (Agbobloshie, Mamprobi/Tuesday, Kumasi, and Techiman Markets) or in inland fish species (Adabraka Market). Table 1 shows the number of traders interviewed in each city, with their ethnicity to some degree reflecting the regional market location.

We purposively selected the traders to represent the range from small-scale retailers to large-scale wholesalers selling a variety of marine and inland fish species and different types of fish products. This was done through a qualitative assessment based upon observations while walking around in the marketplaces. We regularly reviewed the evolving sample to avoid overrepresentation of some trader categories, and we included new categories as we discovered them. Therefore, the sample was not representative of Ghana's fish trader population but it provided insights into the variation in fish traders in the selected marketplaces.

Since we did not encounter any male fish traders in the markets, all 92 sampled traders were women. They ranged in age from 20 to 78 years (mean age 43 years) and had between 1 and 59 years of experience (mean 18 years), and 64.8% were married, 15.4% were widowed, 14.3% were single, and 5.5% were divorced or separated. With regard to education, 30.4% had not received any schooling, 22.8% had attended primary school, 29.3% junior high school, 14.1% senior high school, and 3.3% had tertiary education.

Participation in the study was conditioned on the ethical principle of oral informed consent. Potential interviewees were informed about the purpose and content of the study, that they could withdraw from the study, and would be anonymized in any publications. Some declined our invitation to be interviewed, perhaps suspecting taxation or negative scrutinization of fish qualities or sales strategies, or simply due to being too busy, which we respected. However, most traders were forthcoming. The interviews were conducted at the traders' sales point (e.g., stall, stand, table)

and lasted 20–60 min. Sometimes interviewees invited us into their market stall for elaborate discussions.

The traders preferred to speak their mother tongue or the widely spoken Twi, even in the case of those who knew some English. Accordingly, the Ghanaian second and third authors of this article, who speak Twi and several other local languages, acted as translators and co-researchers when the first author conducted interviews.³ Such interview sessions provided good opportunities for collaborative research. On some occasions, the first author conducted interviews with research assistants as translators, while the two Ghanaian authors individually conducted interviews in local languages. No interviews were tape recorded. The interviewer took notes during interviews, often elaborating on answers to open-ended questions on the back of the one-page questionnaire.

Parallel with the fish trader survey, we conducted a brief survey of 64 fish consumers selected through convenience sampling from people found shopping in the same 11 markets. Their participation was conditioned on oral informed consent, and the interviews lasted 10–20 min. The interviews were conducted by the second author as well as research assistants. The interviewees were asked open-ended questions on the frequency of their fish consumption, which we then categorized into intervals measured in days. It should be noted that the interviewees were selected within or near fish sections in the markets, which could have led to the fish consumption frequency being higher than if we had used a different sampling strategy.

Additional methods included observation and photo documentation of fish species, fish products, activities, equipment, and market facilities and conditions. We conducted 12 key informant interviews with four fish processors, three fish importing company managers, two cold store managers, and representatives of the National Fish Processors and Traders Association (NAFPTA), the Fisheries Commission (FC), and the Ghana Standards Authority (GSA).

The quantifiable survey data were analyzed and charts generated using Minitab statistical software version 19. The qualitative survey and key informant interview data were coded and thematically analyzed through numerous readings of the notes. We also used photographs actively to contextualize, interpret, and verify the interview data.

Fish species and fish names were determined through a procedure whereby we recorded the local fish name provided by the interviewed trader in her local language. We then generated a list of the local fish names, which was translated into English and Latin by the third author, a fish taxonomist. In cases of uncertainty, we compared interview data with

³ The fourth author did not conduct interviews but made observations in the markets while collecting fish samples (see the analysis of these in Hasselberg et al. 2020b).

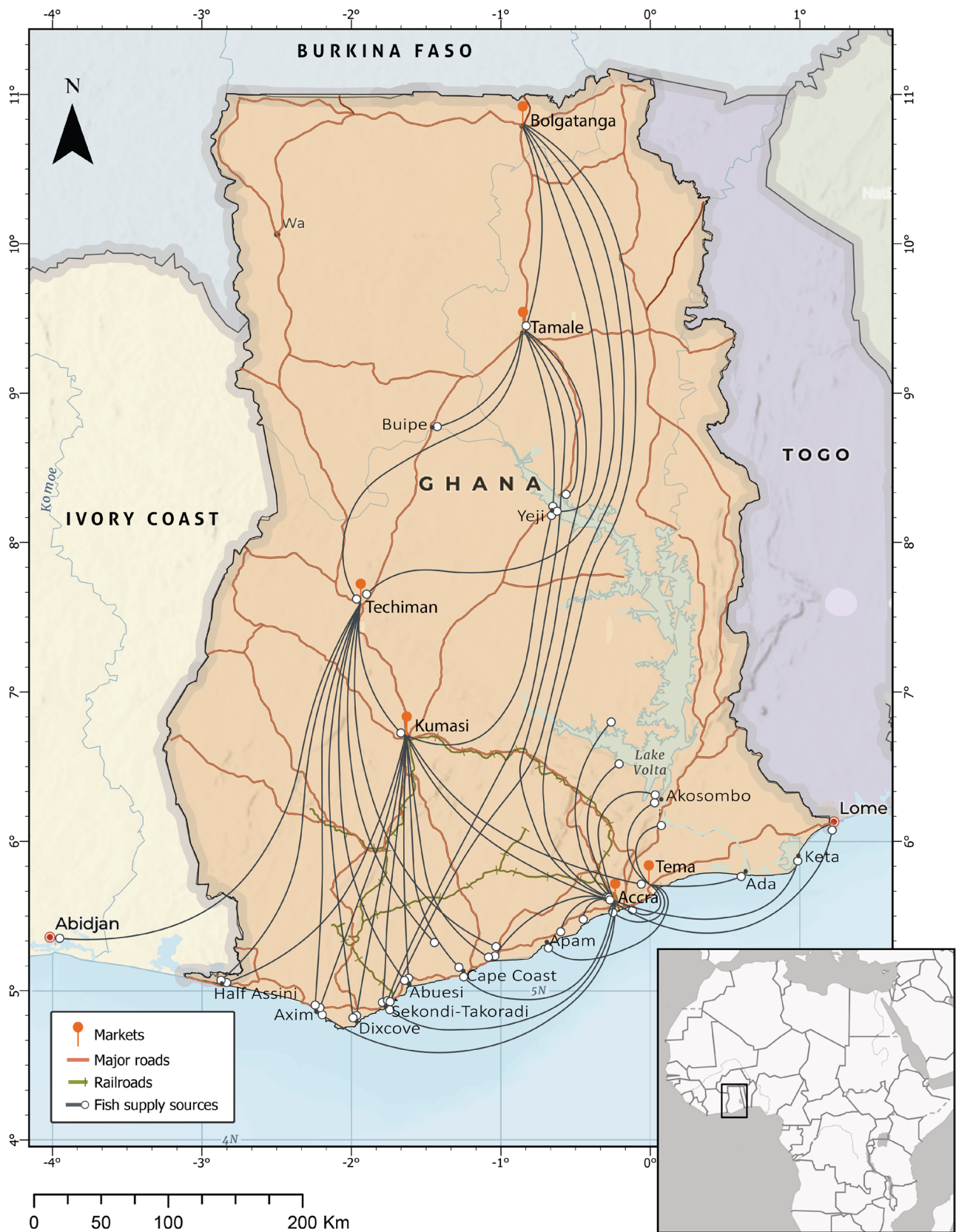


Fig. 1 Locations of fish supply sources used by the traders interviewed in six market cities. Source: Fish trader survey 2017–2018. Background map: Esri, FAO, NOAA; Esri, USGS, GIS User Community

Table 1 Ethnicity of sampled traders by market city. Source: Fish market survey 2017–2018

Market city	Traders' ethnicity										Total no. of traders
	Fante	Ga	Ewe	Frafra	Adangbe	Bono	Dagomba	Effutu	Asante	Other*	
Accra	7	9	9		4	1				1 ^a	31
Tema	2	2			7			1		1 ^b	13
Kumasi	8		1	1					2	2 ^{c,d}	14
Techiman				1		5		1	1	6 ^{e,f,g,h}	14
Tamale	1	1	1					5	2		10
Bolgatanga				10							10
Totals	18	12	11	12	11	6	5	4	3	10	92

*Ethnicities represented by only one or two traders in the sample were categorized as “other,” and were ^aKrobo, ^bAkyem, ^cNzema, ^dKasena, ^eAbosi, ^fWassa, ^gSisala, ^hDagate

photographs and/or used identification keys provided by Kwei and Ofori-Adu (2014).

Results

In our presentation of findings, we explain how traders operate, and how their access to resources (different forms of capital) and ability to activate them is decisive for their capacity to fulfill their twofold and interrelated purpose of meeting customer fish quality demands and making profits.

Sourcing fish and supplying markets

Of the 92 interviewed traders, 61 (66.1%) purchased already processed fish that they then sold wholesale or retail, while 31 (33.7%) traders were combined processor-traders. Traders mainly source fish from coastal and lake/river fishing communities (Fig. 1), either purchasing smoked/dried fish from processors or fresh fish directly from canoes to then process themselves. Some traders are entitled to purchase a canoe's catch because they are married to the owner, are canoe owners themselves, or are a canoe's financier/middleman (called a “standing woman” or “fish mother” in Ghana) (Overå 1993; 1998; Britwum 2009). Fresh farmed tilapia are purchased from fish farms in Lake Volta (Fig. 1).

Traders purchase frozen fish from cold stores in the harbor cities of Tema and Sekondi-Takoradi (Fig. 1), where it has been delivered from trawlers or imported in cartons from various countries, including Morocco, Mauritania, Namibia, Senegal, Spain, Norway, and the Netherlands. Numerous cold storage outlets in urban areas sell imported frozen fish delivered by insulated trucks (Fig. 2, center). Frozen fish are thawed and then smoked in the same way as local fresh fish.

With regard to fish supplies, the traders reported challenges in terms of either seasonal fish supplies (39.5%) or irregular fish supplies (44.2%), low catches (9.3%), and low fish quality (7.0%). Seasonality is more of an issue for

coastal processor/retailers, who largely rely on local canoe catches, than for urban wholesalers/retailers, who often switch to purchasing imported frozen fish when local supplies are low.

The market women demonstrate sophisticated knowledge about the many types of fish traded. In total, the 92 interviewees mentioned that they sold 41 different marine species (72%) and freshwater species (28%) (Table 2).⁴ They also had detailed knowledge about regional and individual consumer preferences regarding species and processing forms, and they were able to inform customers about the origin and processing method for the different species.

As reflected in Table 3, daily fish consumption was common among the 64 interviewed fish consumers, in coastal as well as inland and northern market cities.

Crucially, we found that marine species, particularly sardinellas, anchovies, and mackerel were available in the inland markets and that freshwater fish species such as catfish, tilapia, and African pygmy herring were available in coastal markets. This demonstrates the marketplace system's efficiency in terms of both fish distribution to areas distant from the source and the availability of a variety of fish across regions in Ghana.

Organization of the fish trade

To explain how traders operate in practice in various parts of the supply chain, we present three illustrative case studies. The cases also display the social embeddedness of the traders' economic activities as being crucial for their agency and possibility to make a livelihood. For example, it is evident

⁴ Considering that the species data are from only 11 fish markets, it is likely that an even greater variety of fish species is available in the many marketplaces in different regions of Ghana. Not all species are marketed. Kwei and Ofori-Adu (2014) list 168 marine species, and according to Dankwa et al. (1999), Ghana's freshwater fish fauna includes 157 species.



Fig. 2 Transport of fish. Left to right: large baskets with “Keta school boys” (smoke-dried anchovies) ready for truck transport from Accra to northern Ghana; imported frozen mackerel from Tema offloaded

into cold store in Kumasi; vehicle transporting small baskets between Techiman Market and truck. Photos: Ragnhild Overå

that social capital in the form of collaboration with trading partners who are female (and sometimes male) relatives and long-lasting colleagues (referred to as ‘friends’), often sharing the same ethnicity, is decisive. We start by examining how a retailer and her family on the coast collaborated in fishing, processing, and trade (Case A), then focus our attention farther inland to see how a wholesaler organized the purchase and processing of fish from the coast (Case B), and finally we show how an itinerant trader distributed fish from a wholesale market to a remote rural area in the northern part of Ghana (Case C). All interviewees’ names are pseudonyms.

Case A: Retail of fish from father’s canoe

Ama originally came from a fishing village near Cape Coast. During the last year after completing Senior Secondary School, she had retailed fish in Agbobloshie Market in Accra. Ama said: “I am still learning.”

Ama had learned about the fish trade from her mother and the fish that she retailed was from her father’s canoe. His *watsa* (purse seine net) commonly caught round sardinella, anchovies, Atlantic bumper, scad, lesser African threadfin, and horse mackerel. At home, Ama’s family had a smoking shed with 10 Chorkor smoking ovens.⁵ Female family members helped with the arduous work of smoking fish. Ama’s mother often made fish processing trips lasting

1–2 weeks to the locations where Ama’s father, together with crew, seasonally migrated to fish (e.g., Axim, Takoradi, and Winneba). There, the mother rented smoking ovens to process the fish, helped by accompanying female relatives, as well as locally hired processors, and she organized the transport of the fish to be stored at home for further distribution.

The trading trips that Ama made together with her mother’s sister to Agbobloshie Market lasted from 1 day to 1 month, depending on their fish quantity and turnover. They phoned Ama’s mother when they wanted her to bring more of the sold-out fish types. Ama and her aunt slept between their fish baskets in the market shed. Many other retailers did the same, and even though it was uncomfortable, it felt relatively safe. A major problem was when there was rain and the fish at the bottom of the baskets became soaked. Then, they skinned the fish and took it home to resmoke it. Ama admitted that the work was tough, but she said: “It is a good business and my mother saves for my schooling. I would like to become a nurse.”

As we see, the material capital of the father (canoe producing fish) and mother (fish processing equipment), and their role in Ama’s access to cultural capital (knowledge about fish species, processing, and marketing) and social capital (relations with female kin) were crucial for Ama’s possibility to be a fish trader. The Akan (in this case Fante) matrilineal kinship system appeared to be of particular importance for Ama’s agency, as proceeds from the fish trade were transferred through the mother and the maternal aunt to invest in Ama’s desire for an education.

⁵ The name Chorkor oven is derived from Chorkor, a fishing village and suburb of the capital of Ghana, Accra.

Table 2 Fish species sold by the sampled traders. Source: Fish trader survey 2017–2018

Fish species (no. = 41)	Common English name	Local name	Nature	Traders (no. = 92)
<i>Engraulis encrasicolus</i>	European anchovy	Amoni, Abobi, Kotsoko, “Keta school-boys”	Marine	57
<i>Sardinella aurita</i>	Round sardinella	Kaakama, Eban, Vetsim, Amani	Marine	34
<i>Sierrathrissa leonensis</i>	West African pygmy herring	Wuevi, “One-man-thousand”	Freshwater	25
<i>Scomber japonicus</i>	Chub mackerel	Saman (“salmon”), Awukongula	Marine	19
<i>Auxis thazard</i>	Frigate tuna	Apoku, Opoku	Marine	14
<i>Decapterus</i> sp.	Scad	Ebrum, Pamplobaa	Marine	12
<i>Tilapia</i> sp.	Tilapia	Akpa/Apatire	Freshwater	11
<i>Sphyrna sphyraena</i>	European barracuda	Edoe, Odoe	Marine	11
<i>Chrysichthys nigrodigitatus</i>	Mudfish	Blolovi	Freshwater	9
<i>Penaeus notialis</i>	Pink shrimp	Son, Sesew	Marine	9
<i>Dentex gibbosus</i>	Pink dentex	Shile, Tsile	Marine	8
<i>Trachurus trachurus</i>	Atlantic horse mackerel	Kpanla, Kpala	Marine	8
<i>Chloroscombrus chrysurus</i>	Atlantic bumper	Tantemire, Antele	Marine	6
<i>Elops lacerta</i>	West African ladyfish	Ohenebandi, Ahenamendzi	Marine	6
<i>Hydrocynus</i> sp.	Catfish	Avuvi	Freshwater	5
<i>Lates niloticus</i>	Nile perch	Akwabi/Lesi	Freshwater	4
<i>Caranx hippos</i>	Jack mackerel	Gbaa, Opaa	Marine	3
<i>Orcynopsis unicolor</i>	Plain bonito	Safor, Adzalu	Marine	3
<i>Scomberomorus tritor</i>	Spanish mackerel	Saffo, Dadzu	Marine	3
<i>Penaeus notialis</i>	Shrimp	Soy, Sesew, Bolu	Marine	3
<i>Euthynnus alletteratus</i>	Atlantic little tuna	Apoku, Opoku	Marine	2
<i>Clarias gariepinus</i>	Mud/catfish	Adwen	Freshwater	2
<i>Brachydeuterus auritus</i>	Bigeye grunt	Boe, Eboe	Marine	2
<i>Elagatis bipinnulata</i>	Rainbow runner	Doktorfish, Odzegba	Marine	2
<i>Ilisha africana</i>	West African Ilisha	Kanfena, Kaffa	Marine	2
<i>Istiophorus</i> sp.	Marlin	Ekyinekyin, Onyankle	Marine	2
<i>Pseudotolithus senegalensis</i>	Cassava croaker	Ekan, Nkan	Marine	2
<i>Synodontis</i> sp.	Wahrindi	Chechevi	Freshwater	2
<i>Auchenoglanis occidentalis</i>	Giraffe catfish	Kpo	Freshwater	1
<i>Bagrus bajad</i>	Bayad	Yalefour	Freshwater	1
<i>Citharinus citharus</i>	Moonfish	Takra	Freshwater	1
<i>Gymnarchus niloticus</i>	Aba	Odor	Freshwater	1
<i>Acanthurus monravier</i>	Monrovia doctorfish	Adzesa, Adesa	Marine	1
<i>Ablennes hians</i>	Flat needlefish	Konsuano, Agbana	Marine	1
<i>Epinephelus aeneus</i>	Grouper	Efi, Shoi	Marine	1
<i>Ethmalosa fimbriata</i>	Shad, Bonga	Kokole, Edzado	Marine	1
<i>Galeoides decadactylus</i>	Lesser African threadfin	Sukue, Tsukwei kpakpa	Marine	1
<i>Hemirhanphus brasiliensis</i>	Ballyhoo halfbeak	Sese, Osese	Marine	1
<i>Mugil cephalus</i>	Flathead grey mullet	Mumu, Nnaata	Marine	1
<i>Priacanthus arenatus</i>	Atlantic bigeye	Odame, Anihonton	Marine	1
<i>Trichiurus lepturus</i>	Ribbonfish	Wawanyan, Ayilo	Marine	1

Case B: Inland market women collaborating with coastal processors

“Yaba” was a wholesaler in Kumasi Central Market (KCM), one of West Africa’s largest markets. Yaba’s

mother was a fish trader, and Yaba had learned the trade by assisting her in trading fish from their coastal hometown to Kumasi, so Yaba had partly grown up in Kumasi. Yaba was energetic and humorous, and she worked hard: “I have four children to take care of, so

Table 3 Frequency of fish consumption among interviewed consumers. Source: Consumer survey 2017–2018

Market city	Frequency of fish consumption per week				No. of consumers
	7 days	4–6 days	1–3 days	0 days	
Accra	13	1	1	-	15
Tema	3	4	-	-	7
Kumasi	8	3	4	1	16
Techiman	6	-	-	-	6
Tamale	9	-	1	-	10
Bolgatanga	6	1	3	-	10
Totals	45 (69%)	9 (14%)	9 (14%)	1 (2%)	64 (100%)

I cannot play or joke. I take my work very seriously.”

Yaba’s market location was attractive as her stall was in a busy area with many customers. According to Yaba, her customers paid well because of her good reputation for selling quality fish and being trustworthy in matters involving money: “They know me.”

Yaba purchased fish from “her own” processors in her coastal home region, many of whom were relatives. She had an agent who visited them approximately once a month to inspect the processing, packaging, and storage operations. The purpose was to inspect the fish quality and to negotiate fish prices that were in accordance with fish quality and quantities. Yaba phoned the agent “all the time” to supervise her in the process. During the rainy season (May–July), fish catches are low, and fish prices correspondingly high, whereas in the main fishing season (August–September and subsequent shorter seasons), fish are in abundance and prices relatively low. Then, Yaba (through the agent) purchased large quantities of fish and, for a fee, “her” processors kept the fish in “storage ovens” for 8–10 months until the lean season, when there is a shortage of fish in the market and prices are high. This coordinated collaboration with processors resulted in higher profits and evened the seasonal fluctuations in the flows of fish supplies from the coast to Kumasi.

The coastal processors deliver the fish (mostly smoke-dried anchovies and sardinellas) in large baskets (Fig. 2, left) to an agreed collecting point where a truck will be waiting. The agent pays the driver per basket for transport to Kumasi. Trucks usually contain fish baskets belonging to several different traders. Drivers, all of whom are male, are important collaboration partners, who may be entrusted with delivering money when traders (and their agents) know them well. On average, Yaba received 15 large baskets of fish weekly. Her customers were mainly female wholesalers who travelled to Kumasi from northern Ghana and Burkina Faso. They generally purchased 3–8 baskets, and occasionally as many

as 10 baskets, although that was very rare because, as Yaba stated, “They are restricted by money.”

Also in this case, Akan (in this case Nzema) matrilineal kinship has been decisive for Yaba’s training and for access to high-quality fish. Even more important than access to fish supplies are the moral obligations that to some extent prevent relatives from “cheating.” However, even transactions with kin need to be monitored and relations of trust are crucial for Yaba’s agency. The well-established collaboration with the agent (and drivers), with frequent mobile phone communication as a crucial factor in the maintenance of the trust, enabled Yaba to engage in long-distance trade and long-term fish storage. Thereby she profited from the seasonal fluctuations of the fisheries and contributed to stabilizing the annual availability of fish to consumers at the KCM.

Case C: Distribution of marine small fish to the northern savannah

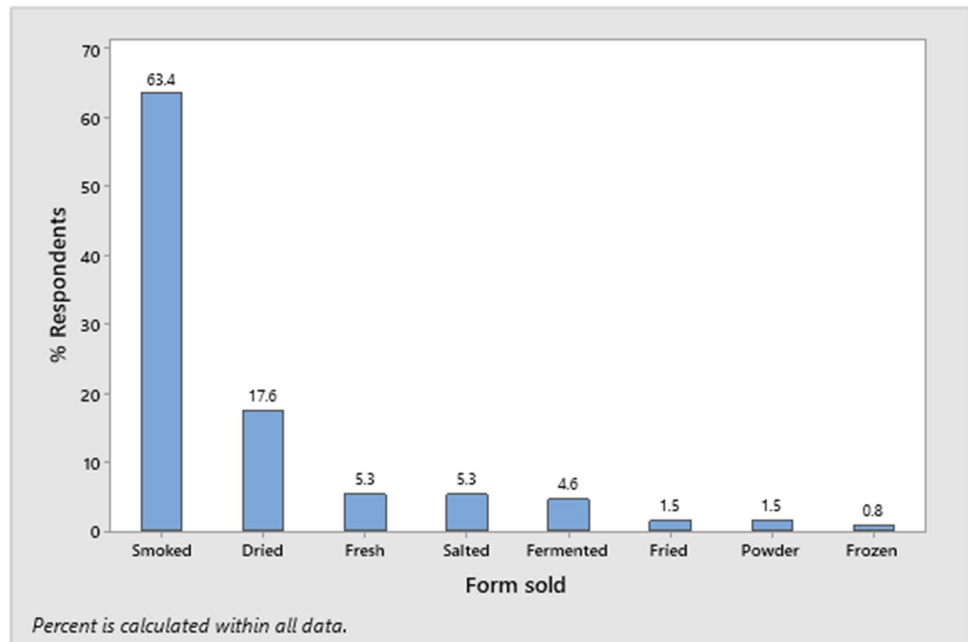
“Ziema” lived in Wa in north-western Ghana (Fig. 1), was married to a public servant, and had two children. She was previously a cloth seller but since sales were slow, she switched to the fish trade, and regularly purchased “Keta-school-boys” at the large Techiman wholesale market.

Ziema travelled once per month by bus, leaving Wa at 9 p.m., arriving in Techiman at 4 a.m. She usually purchased 20 small baskets (Fig. 2, right). During the main fishing season, she purchased up to 50 baskets. To pay for the fish, she withdrew cash from her bank account in Techiman or she bought the fish on credit, and later transferred the payment by mobile phone. She paid men to drive small “cars” (tricycles, Fig. 2, right) to transport her fish to the Wa truck. Ziema travelled home by bus (the same day as she arrived) leaving Techiman at 1 p.m. and arriving in Wa at 8 p.m., where “helping brothers” (carriers) unloaded her fish baskets and took them by “car” to the storage room that she rented for 400 GHS⁶ (88.5 USD) per year.

Ziema sold fish retail in a marketplace in Wa once per week. She also sold fish to a catering business. However, Ziema’s main regular customer was her “junior father” (uncle). He paid 140 GHS for each of the fish baskets that Ziema purchased at 100 GHS or 120 GHS in Techiman. Ziema calculated her transport costs per basket as follows: carrying from Techiman market to “car” (0.5 GHS), “car” transport to truck (0.5 GHS), truck transport from Techiman to Wa (3 GHS), carrying from truck to “car” (0.5 GHS), and “car” transport to Wa storage room (0.5 GHS). Total transport costs were 5 GHS per basket, which meant that

⁶ In February 2018 (when the interview was conducted) the exchange rate was 0.2216 GHS to 1 USD.

Fig. 3 Form in which fish products were sold by interviewed traders. Source: Market survey 2017–2018



she could make a profit of 15–25 GHS (3.3 – 5.5 USD) per basket after sales to her uncle.

Ziema’s uncle lived in her natal village, located a 3-h drive (or 6 h during the rainy season) from Wa. Through the distribution efforts of Ziema and her uncle, anchovies and sardines are made available to consumers in a remote village on the savannah 700-km inland from the coast.

In this case, social capital through the patrilineal kinship system in Dagaaba society was important for Ziema’s agency. The social linkages with the rural home community through her paternal uncle provided a fish marketing opportunity. Ziema’s urban social network (knowing caterers) and the husband’s moral (though not economic) support were also enabling factors. However, Ziema’s profit margins were meager, as her periodic need to purchase fish on credit shows. Poor roads were also constraining. Nevertheless, fish trade represented an improved income generation alternative.

Once the fish have arrived in the market, fish traders activate a range of quality enhancing and sales-promoting strategies to make profits and stay in business over time. In the next section, we explain how traders preserve, display, and sell the various fish products.

Fish products and quality enhancing practices

The most common form of processing fish in Ghana is smoking (Fig. 3). Large fish are usually soft-smoked in oil drum ovens, whereas small fish are smoked on Chorkor ovens, often after being pre-dried on wire mesh trays. Dryness prolongs the shelf life of the fish. Dried fish products are mostly made from small

species, which are spread out and dried either directly or on a cover on the ground, on a beach, a cement floor, or pavement. Larger fish can be salted before drying to produce strong-tasting *koobi*, which is added to stews as a combined ASF and condiment. A great variety of fermented fish products have the same function.

Fish powder is milled from smoked anchovies and sardines (Fig. 4, left). Many traders removed the highly nutritious parts of the skin, guts, and head before milling the fish. However, the traders reported that customers in northern Ghana did not de-head the smoked anchovies/sardines before milling them into powder, and that they commonly mixed fish powder into millet porridge and stews. Also, smoked shrimps were milled into powder. Ghanaians commonly mix fish and shrimp powders to prepare the popular spicy sauce *shito* and mix fish/shrimp powder into baby food.

Fish are not sold by weight but by volume in the marketplace. There are many standardized volumetric measures used to determine prices: by piece or heap, in standard sizes of tins, large bags, small plastic sachets, bowls, and baskets (Fig. 4, center and right). Standardized sizes are often established based on containers of well-known brands of flour, powdered milk, margarine, and other products. Basket-makers deliver standardized sizes too. Retailers often empty large baskets or sacks purchased from wholesalers and “remeasure” the fish into standard-sized small baskets, lightly rinsing the fish in the process (Fig. 4, center). Thereby they enable customers to inspect the quantity, appearance, smell, and texture of the fish.

Display techniques and styles are important for making fish products attractive, such as oiling large fish cutlets to



Fig. 4 Fish powder and methods used of measuring processed fish. Left to right: fish powder made from sardines (left) and shrimp (right); smoked sardines in standard-sized small fish baskets; standard-sized measuring tins. Photos: Ragnhild Overå



Fig. 5 Display techniques and styles for marketing fish. Left to right: brown paper bases for placement of fish heaps; smoked anchovies packed in sachets to avoid customers asking for “add-ons;” mosquito

coil placed among pieces of smoked tuna to keep flies away. Photos: Ragnhild Overå

make them look shiny. We observed that retailers sorted and neatly stacked fish by their size and priced the heaps accordingly (Fig. 5). Adding a few fish to the heap was a sales and customer relation strategy. Traders in Ghana generally use this add-on system (called “to so” in Twi) for quantity bargaining over foodstuffs that are divisible into very small, inexpensive units (Clark 1994: 131).

Storage of unsold fish is a crucial stage in the marketing process, as deteriorating fish quality results in price reductions. Having to discard spoiled fish represents a serious economic loss. The traders (65% of the interviewees) regularly

needed to store unsold fish for the next day or next few days, and they used a variety of preservation methods (Fig. 6).

To protect the fish from exposure to air, dust, and insects, traders line the insides of baskets with brown paper and create layers of fish which are then placed on top of each other (Fig. 7, left). New brown paper is expensive, so many traders use paper from cement sacks, turning the side of the paper that has been in contact with the cement away from the fish to avoid contamination. It is important to seal the covered fish baskets with cloth and polythene, and to tie them with ropes to ensure that they are as airtight as possible.

Fig. 6 Preservation methods for unsold fish products. Source: Market survey 2017–2018

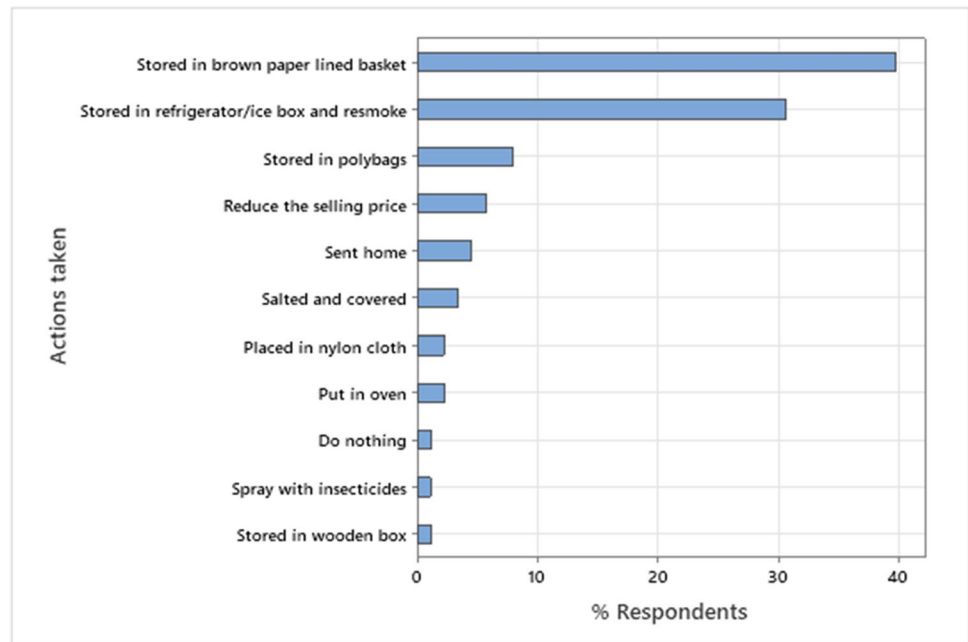


Fig. 7 Methods used for preserving and storing fish. Left to right: smoked anchovies in large baskets are packed in layers of brown paper; store room in a marketplace; ovens for resmoking fish in a marketplace. Photos: Ragnhild Overå

Traders stored unsold fish either on their rented stall or they rented space in a storage room or cold room⁷ in the marketplace (Fig. 7, center), or they took the fish home. Considerable time, labor, and costs were involved in transporting unsold fish to fish retailers' homes for storage, resmoking, repackaging, and transportation back to the market. Some traders resmoked and/or stored unsold fish inside the market in ovens (Fig. 7, right), which they owned, borrowed, or rented from other traders. The traders reported that medium-sized fish could be stored for 1–2 months when resmoked regularly. Smoke-dried sardines and anchovies could be stored from 1 month to 1 year, depending on how dry they

were and how often they were resmoked. Fresh fish could be kept for 1–2 weeks if ice was added regularly.

The very few traders who had freezer facilities at home could develop a “just-in-time” delivery strategy. One trader interviewed in Accra purchased frozen fish from cold stores in Tema every Friday, stored it in her freezer at home, and then smoked it in suitable portions to be sold the next day. From her retail stall in the market, she assessed customer demand and then phoned her sister at home informing her about the quantity of fish to be smoked for the following day. In that way, her smoked fish were always fresh. She avoided throwing away unsold fish, although sometimes she had to lower the price towards the end of the day.

The most frequently mentioned hygiene problem was houseflies that laid eggs, which later hatched into maggots

⁷ All 11 marketplaces had small cold rooms, and 4 (e.g., Tema, Madina, Asafo, and Makola) had larger cold rooms too.

in the fish, especially the fleshy fish types. A preventive measure was to place mosquito coils between fish pieces. Mold was a problem too, and oiling of fish was sometimes used as a means to conceal such damage. Also, insects and rodents could damage the fish, despite meticulous packaging. Spraying with insecticides, usually not directly onto the fish but inside storage rooms and other surroundings, was done by the traders themselves and at regular intervals by market management staff. Small amounts of insecticides were sometimes placed between the layers and at the bottom of baskets because, according to one trader, “That is where the insects creep in.” Several traders emphasized the importance of wrapping the chemicals in cloth or paper to avoid direct contact with the fish products.

Sometimes fish were thrown away, even though the traders communicated extensively with colleagues to exchange market information and were experienced in estimating supply and demand. Traders were not always transparent about the quality of their fish. However, many claimed that they would rather throw away fish than sell spoiled fish, especially to regular customers with whom they cultivated over time what Clark (1994: 216) calls “personalized commercial relations.” Thus, it was necessary for traders to maintain the quality of their fish in order to maintain their reputation and remain in business in the long run.

The many fish quality enhancing and sales promoting actions demonstrate market women’s capacity to enhance their livelihoods. Their practices mostly enhanced fish-quality, though some of them may compromise fish safety. However, the practices are skilfully adapted to a context in which infrastructure (e.g. sanitation, storage) in most marketplaces are inadequate. Traders reported that a major issue that their leaders raise with market administrators is shortage of storage facilities. Lack of inclusive consultation and government funding, but also contestations among the traders themselves (e.g. on storage facility ownership), are institutional barriers to traders’ agency with regards to saving labor, time, and money, and to offering high-quality fish products for sale.

Discussion

Our study provides insight into how informal female traders make fish available by linking fish supply sources and fish processors to their customers, thus enabling consumers’ fish access (HLPE 2021). Small-scale fisheries based domestic fish marketing systems have been described as being resilient and pro-poor (Moreau and Garaway 2021), and the case of Ghana’s fish market is a case in point.

The market women’s provision of the preferred forms of processed fish (Fig. 3) enhances consumers’ agency by enabling their capacity to access and choose affordable and culturally acceptable ASF. Although our fish consumption

frequency data (Table 3) should be interpreted with caution, the findings confirm the pattern of frequent fish consumption observed by Onumah et al. (2020). The service provided by the traders of selling tiny fish portions is particularly important for the possibility for the poor to consume fish frequently.

The fish trade in Ghana also represents an opportunity for women to make a livelihood. Without much starting capital, it is possible to start trading on a small scale, or by assisting an established trader. The skills are transferred from one generation to the next, but also represents a livelihood option for new entrants into the profession, who acquire skills through practical experience and collegial collaboration. Sometimes fish trade is even a better option for generating income than other typical female jobs (e.g., cloth seller (Case C), and even formal jobs such as secretary and teacher). Moreover, in some cases, fish trading also represents an avenue for social mobility for the traders themselves or their children (e.g., spending the income on education as in Case A).

The socially embedded and personalized trust-based market system (Clark 1994; 2000; Chalfin 2000; Overå 2006) involves risks of broken contracts (e.g., credit relations and lack of transparency in fish quality). However, in the type of informal economic environment that fish traders operate, they demonstrate agency by activating social capital through kinship relations, social networking, reputation cultivation, and monitoring of fish quality and transactions through social control (face-to-face or via the mobile phone), which minimize risk and strengthen trade relations. This has positive implications not only for the profitability of their trade but also for the flexibility and resilience of the trade system, and this has implications for FSN.

For example, wholesalers’ strategies of storing fish purchased during bumper season supply gluts for later sale in the lean season (Case B) enhance the stability of consumers’ fish availability and access. Likewise, when traders smoke and retail imported fish during periods of low local catches, they not only contribute to stabilizing consumers’ physical access to fish, but also make imported fish available in processed forms that meet consumers’ culinary preferences (e.g., fish smoked according to local taste) and their practical needs (e.g., store fish at home without refrigeration facilities). Onumah et al. (2020) confirm that there is an annual pattern in Ghana of relatively low fish imports during bumper season for local fisheries and high imports during the lean season. The economic strategies of the traders thus contribute to the fish utilization as well the agency dimension of FSN (HLPE 2021: 10).

Another aspect of traders’ role in linking fishers and consumers is their sourcing of an enormous variety of fish species (Table 2), whereby fish traders represent an important link between biodiversity and FSN (Moreau and Garaway

2018). As Thilsted et al. (1997) emphasized 25 years ago, consuming a variety of small fish species that when combined contained many different micronutrients, has proven to be highly beneficial for nutrition and health. A 100-g portion of raw anchovies (whole fish)—the most common species sold by the traders (Table 2)—covers the daily recommended nutrient intake of vitamins B12 (adult women), and approximately 40–60% the recommended intake of vitamin D, calcium, zinc, and the long-chained marine n-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Aakre et al. 2020). Studies from Sri Lanka and north-west Africa have documented that whole fish are in general more nutrient dense than fish fillet for most nutrients; for example, a horse mackerel fillet would cover less than 10% of the daily recommended intake of calcium, zinc, iron, vitamin A, and the n-3 fatty acids EPA and DHA (Aakre et al. 2020; Reksten et al. 2020). However, processing methods such as sun drying, smoking, frying, and cooking can reduce or destroy nutrients, such as vitamin A and iodine, found in fresh fish (Roos et al. 2002; Hasselberg et al. 2020b; Dahl et al. 2020).

Clearly, the lack of freezing and refrigeration facilities is a major problem in Ghana's fish market. Consequently, fish preservation methods during storage periods are time-consuming and cumbersome. In a study of small pelagic fish value chains, Nunoo et al. (2015) estimated that physical post-harvest losses were as low as 5%. This was attributed to the preservation methods used by processors and traders, which resulted in remarkably low food loss and waste (FLW) levels for such a perishable product as fish. However, as the fish were transported, stored, and displayed in various stages of the supply chain, the quality of the fish deteriorated over time and in turn product value decreased, leading to economic losses for traders (Nunoo et al. 2015).

In terms of consequences for fish safety, sometimes storage periods that are too long, with frequent repackaging and transportation back and forth to the market, can cause recontamination from hands and other contact surfaces, and aflatoxin-producing molds may contaminate the fish (García et al. 2015). Furthermore, fish safety is reduced when traders constantly resmoke fish to prolong its shelf life, adding to the already high PAH levels in the smoked fish received from processors. Smoking has also been shown to reduce the levels of some nutrients in fish (Hasselberg et al. 2020b). Therefore, although traders do their best to enhance fish safety and quality through their methods, improvements are needed to complement their efforts through training that creates awareness of good hygiene practices to prevent or reduce contamination and to improve the safety and quality of fish, as this has a direct impact on consumers' health, prevents wastage, and influences market prices. Potentially, traders could also play a role in linking processors investing

in improved techniques for smoking fish, which have proven to yield smoked fish with a PAH content lower than the levels in traditional kiln products and below regulatory limits (Bomfeh et al. 2019), with consumers willing to pay higher prices for improved products. Limited market uptake is a barrier to improved processing technology adoption, and building on traders' marketing skills and customer relations could be one avenue towards promoting processing techniques that yield safer fish products.

The many infrastructural deficits reported by the traders in our study have implications for their time use, marketing efficiency, and welfare at work, as well as for fish quality and safety. Generally improved roads, especially in remote areas, would make fish distribution easier. In the marketplaces amenities that would improve working conditions include facilities for fish handling (water taps, sales space, storage rooms, insect/rodent control), sanitation (toilet and bathing facilities), personal security (accommodation for traveling traders), child-care facilities, and access to low-cost credit. All of these are public infrastructures that, if addressed and invested in, would strengthen the agency (Kabeer 2021) of traders collectively as a group and as individuals in their capacity to earn better incomes and offer quality fish products to consumers. This would also be beneficial from an FSN and public health perspective.

Conclusion

We conclude that the perspective on fish supply chain governance needs to be reshuffled from an almost one-sided focus on the fish resources and production, to a stronger focus on post-harvest activities and a holistic view on the value of fish resources for FSN (Belton et al. 2022; Simmance et al. 2021). To this end, state and city governments should not only appreciate the efforts of female informal traders, who constitute the backbone of Ghana's resilient and pro-poor fish distribution system, but also in their budgets to prioritize market infrastructure upgrading, financial support, and training in fish quality and safety. Infrastructural upgrading must include small-scale traders and not contribute to their exclusion, relegating them to unattractive market locations. Improvements in processing and storage technologies should be developed in collaboration with the processors and traders in an including manner, building upon their practical experience-based skills and contextual knowledge so that they can offer quality nutritious fish products that are not only affordable but also safe.

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Declarations

Competing interests The authors declare no competing interests.

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References

- Aakre, I., A. Bøkevoll, J. Chaira, F.Z. Bouthir, S. Frantzen, A. Kausland, and M. Kjellevold. 2020. Variation in nutrient composition of seafood from north west Africa: Implications for food and nutrition security. *Foods* 9 (10): 1516. <https://doi.org/10.3390/foods9101516>.
- Ameyaw, AA Breckwoldt., H. Reuter, and D.W. Aheto. 2020. From fish to cash: Analyzing the role of women in fisheries in the western region of Ghana. *Marine Policy* 113: 103790. <https://doi.org/10.1016/j.marpol.2019.103790>.
- Arthur, C.T., and A. Osei-Somuah. 2004. Microbial contamination of smoked *Anchovis*. *Ghana Journal of Agricultural Science* 37 (1): 69–74.
- Asamoah, E.K., F.K.E. Nunoo, S. Addo, J.O. Nyarko, and G. Hyldig. 2020. Polycyclic aromatic hydrocarbons (PAHs) in fish smoked using traditional and improved kilns: levels and human health risk implications through dietary exposure in Ghana. *Food Control* 121: 107576.
- Asiedu, B., P. Okpei, F.K.E. Nunoo, and P. Failler. 2021. A fishery in distress: An analysis of the small pelagic fishery of Ghana. *Marine Policy* 129: 104500.
- Atta-Mills, J., J. Alder, and R.U. Sumaila. 2004. The decline of a regional fishing nation: the case of Ghana and West Africa. *NRF: Natural Resources Forum* 28: 13–21.
- Ayilu, R.K., T.O. Antwi-Asare, P. Anoh, A. Tall, N. Aboya, S. Chimatiro, and S. Dedi. 2016. *Informal artisanal fish trade in West Africa: improving cross-border trade*. Program Brief: 2016–37. Penang: WorldFish.
- Belton, B., D. Johnson, E. Thrift, J. Olsen, M.A.R. Hossain, and S.H. Thilsted. 2022. Dried fish at the intersection of food science, economy, and culture: a global survey. *Fish and Fisheries* 00: 1–22 Article. <https://onlinelibrary.wiley.com/doi/10.1111/faf.12664>.
- Bennett, A., X. Basurto, J. Virdin, et al. 2021. Recognize fish as food in policy discourse and development funding. *Ambio* 50: 981–989. <https://doi.org/10.1007/s13280-020-01451-4>.
- Bomfeh, K., L. Jacxsens, W.K. Amoa-Awua, I. Tandoh, E.O. Afoakwa, E.G. Gamarro, Y. Diei Quadi, and B. De Meulenaer. 2019. Reducing polycyclic aromatic hydrocarbon contamination in smoked fish in the Global South: A case study of an improved kiln in Ghana. *Journal of the Science of Food and Agriculture* 99 (12): 5417–5423.
- Bourdieu, P. 1977. *Outline of a theory of practice*. Cambridge: Cambridge University Press.
- Britwum, A.O. 2009. The gendered dynamics of production relations in Ghanaian coastal fishing. *Feminist Africa* 12: 69–85.
- Chalfin, B. 2000. Risky business: Economic uncertainty, market reforms and female livelihoods in Northeast Ghana. *Development and Change* 31: 987–1008.
- Clark, G. 1994. *Onions are my husband. Survival and accumulation by West African market women*. Chicago: University of Chicago Press.
- Clark, G. 2000. Small-scale traders' key role in stabilizing and diversifying Ghana's rural communities and livelihoods. In *Women farmers and commercial ventures. Increasing food security in developing countries*, ed. Anita Spring, 253–273. Boulder: Lynne Rienner.
- Cohen, P.J., E.H. Allison, N.L. Andrew, J. Cinner, L.S. Evans, M. Fabinyi, L.R. Garces, et al. 2019. Securing a just space for small-scale fisheries in the blue economy. *Frontiers in Marine Science* 6: 171. <https://doi.org/10.3389/fmars.2019.00171>.
- Cruikshank, B. 1853. *Eighteen years on the Gold Coast of Africa including an account of the native tribes and their intercourse with Europeans*. London: Hurst and Blackett.
- Dahl, L., A. Duinker, S. Næss, M.W. Markhus, I. Nerhus, L.K. Midtbø, and M. Kjellevold. 2020. Iodine and mercury content in raw, boiled, pan-fried, and oven-baked atlantic cod (*Gadus morhua*). *Foods* 9: 1652. <https://doi.org/10.3390/foods9111652>.
- Daniell, W.-E. 1856. On the ethnography of Akkrah and Adampe, Gold Coast, Western Africa. *Journal of the Ethnological Society* 4: 1–32.
- Dankwa, H.R., E-K. Abban, and G.G. Teugels. 1999. *Freshwater fishes of Ghana: identification, distribution, ecological and economic importance*. Tervuren: Royal museum for Central Africa.
- Dovlo, E., K. Amador, and N. Nkrumah. 2016. *Report on the 2016 Ghana Marine Canoe Frame Survey*. Information Report No. 36. Accra: Fisheries Commission, Ministry of Fisheries and Aquaculture Development.
- Dowlati, M., S.S. Mohtasebi, M. Omid, S.H. Razavi, M. Jamzad, and M. de la Guardia. 2013. Freshness assessment of gilthead sea bream (*Sparus aurata*) by machine vision based on gill and eye color changes. *Journal of Food Engineering* 119 (2): 277–287.
- Environmental Justice Foundation, and Hen Mpoano. 2019. *Stolen at sea. How illegal 'saiko' fishing is fuelling the collapse of Ghana's fisheries*. https://ejfoundation.org/resources/downloads/Stolen-at-sea_06_2019.pdf. Accessed 22 June 2022.
- FAO. 2016. *Fishery and aquaculture country profiles: The Republic of Ghana*. Rome: Food and Agriculture Organization.
- FAO. 2020. *The state of world fisheries and aquaculture 2020: Sustainability in action*. <https://doi.org/10.4060/ca9229en>. Accessed 22 June 2022.
- García, M.R., C. Vilas, J.R. Herrera, M. Bernárdez, E. Balsa-Canto, and A.A. Alonso. 2015. Quality and shelf-life prediction for retail fresh hake (*Merluccius merluccius*). *International Journal of Food Microbiology* 208: 65–74.
- Ghana Statistical Service. 2021. *Ghana 2021 population and housing census: preliminary report*. <https://census2021.statsghana.gov.gh/events.php?tokenevents=MTg0NzMsOTQyNi4zNTU=&Preliminary-Report>. Accessed 22 June 2022.
- Golden, C.D., J.Z. Koehn, A. Shepon, S. Passarelli, C.M. Free, D.F. Viana, H. Matthey, et al. 2021. Aquatic foods to nourish nations. *Nature* 598: 315–320.
- Hasselberg, A.E., I. Aakre, J. Scholtens, R. Overå, J. Kolding, M. Bank, A. Atter, and M. Kjellevold. 2020a. Fish for food and nutrition security in Ghana: challenges and opportunities. *Global Food Security* 26: 100380. <https://doi.org/10.1016/j.gfs.2020a.100380>.

- Hasselberg, A.E., L. Wessels, I. Aakre, F. Reich, A. Atter, M. Steiner-Asiedu, S. Amponsah, et al. 2020b. Composition of nutrients, heavy metals, polycyclic aromatic hydrocarbons and microbiological quality in processed small indigenous fish species from Ghana: implications for food security. *PLOS One* 15(11): e0242086. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242086>.
- Hernæs, P.O. 1991. *Modernizing Ghanaian fisheries: The need for 'social carriers' of technology*. Oslo: Ad Notam.
- HLPE. 2014. *Sustainable fisheries and aquaculture for food security and nutrition*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- HLPE. 2020. *Food security and nutrition: building a global narrative towards 2030*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- Kabeer, N. 2021. Three faces of agency in feminist economics: Capabilities, empowerment, and citizenship. In *The Routledge handbook of feminist economics*, ed. G. Berik and E. Kongar, 99–107. London: Routledge.
- Kawarazuka, N., and C. Béné. 2010. Linking small-scale fisheries and aquaculture to household nutritional security: An overview. *Food Policy* 2 (4): 343–357.
- Kombat, E.O., F.K. Nunoo, J.A. Ampofo, and P.G. Addo. 2013. Effects of environmental conditions on the microbiological quality of two small marine pelagic fishes landed in Accra and Tema, Ghana. *Archives of Applied Science Research* 5 (2): 180–188.
- Kwei, E., and D.W. Ofori-Adu. 2014. *Fishes in the coastal waters of Ghana*. Tema: Ronna.
- Kwenin, W.K.J., J.M. Seidu, and F. Boadi-Amoah. 2013. Nutritional profile, sensory properties and microbial quality of solar-dried tilapia (*Oreochromis niloticus*). *International Journal of Engineering and Innovative Technology* 2 (7): 285–290.
- Mensah, P., D. Yeboah-Manu, K. Owusu-Darko, and A. Ablordey. 2002. Street foods in Accra, Ghana: How safe are they? *Bulletin of the World Health Organization* 80: 546–554.
- Moreau, M.-A., and C.J. Garaway. 2018. 'Fish rescue us from hunger': The contribution of aquatic resources to household food security on the Rufiji River floodplain, Tanzania, East Africa. *Human Ecology* 46: 813–848.
- Moreau, M.-A., and C.J. Garaway. 2021. Trading fast and slow: Fish marketing networks provide flexible livelihood opportunities on an East African floodplain. *Frontiers in Sustainable Food Systems* 5: 742803. <https://doi.org/10.3389/fsufs.2021.742803>.
- Nunoo, F.K.E., A.A. Boateng, K. Agyekum, and U.R. Sumaila. 2009. When trash fish is treasure: The case of Ghana in West Africa. *Fisheries Research* 96: 167–172.
- Nunoo, F.K.E., B. Asiedu, K. Amador, D. Belhabib, V. Lam, R. Sumaila, and D. Pauly. 2014. Marine fisheries catches in Ghana: Historic reconstruction for 1950 to 2010 and current economic impacts. *Reviews in Fisheries Science and Aquaculture* 22: 274–283.
- Nunoo, F.K.E., B. Asiedu, E.O. Kombat, and B. Samey. 2015. *Sardinella and other small pelagics value and supply chains of the fishery sector, Ghana*. The USAID/Ghana Sustainable Fisheries Management Project (SFMP). Narragansett: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island and Netherlands Development Organisation.
- Odotei, I. 1992. The migration of Ghanaian women in the canoe fishing industry. *MAST* 5 (2): 88–95.
- Onumah, E.E., E. Quaye, A.K. Ahwireng, and B. Champion. 2020. Fish consumption behaviour and perception of food security of low-income households in urban areas of Ghana. *Sustainability* 12 (19): 7932. <https://doi.org/10.3390/su12197932>.
- Overå, R. 1993. Wives and traders: Women's careers in Ghanaian canoe fisheries. *MAST* 6 (1–2): 110–135.
- Overå, R. 2005. When sisters become competitors: Coastal women's innovative strategies and access to trawlers' by-catch in Ghana. In *Gender, globalization and the fisheries*, ed. B. Neis, M. Binkley, and S. Gerrard, 136–151. Nova Scotia: Fernwood Books.
- Overå, R. 2006. Networks, distance and trust: Telecommunications development and changing trading practices in Ghana. *World Development* 34 (7): 1301–1315.
- Overå, R. 2007. When men do women's work: Structural adjustment, unemployment and changing gender relations in the informal economy of Accra, Ghana. *Journal of Modern African Studies* 45: 539–563.
- Overå, R. 2011. Modernisation narratives and small-scale fisheries in Ghana and Zambia. *Forum for Development Studies* 38 (3): 321–343.
- Overå, R. 1998. *Partners and competitors: gendered entrepreneurship in Ghanaian canoe fisheries*. Doctoral dissertation, University of Bergen. <https://bora.uib.no/bora-xmlui/handle/11250/2726334>.
- Paudyal, N., V. Anihouvi, J. Hounhouigan, M.I. Matsheka, B. Sekwati-Monang, W. Amoa-Awua, A. Atter, et al. 2017. Prevalence of foodborne pathogens in food from selected African countries—a meta-analysis. *International Journal of Food Microbiology* 249: 35–43.
- Reksten, A.M., T. Somasundaram, M. Kjellevoid, A. Nordhagen, A. Bøkevoll, L.M. Pincus, A.A. Rizwan, et al. 2020. Nutrient composition of 19 fish species from Sri Lanka and potential contribution to food and nutrition security. *Journal of Food Composition and Analysis* 91: 103508. <https://doi.org/10.1016/j.jfca.2020.103508>.
- Roos, N., T. Leth, J. Jakobsen, and S. Thilsted. 2002. High vitamin A content in some small indigenous fish species in Bangladesh: perspectives for food-based strategies to reduce vitamin A deficiency. *International Journal of Food Sciences and Nutrition* 53 (5): 425–437.
- Salia, M., N.N. Nsawah-Nuamah, and W.F. Steel. 2011. Effects of mobile phone use on artisanal fishing market efficiency and livelihoods in Ghana. *Electronic Journal of Information Systems in Developing Countries* 47 (6): 1–26.
- Scott, B., V. Curtis, T. Rabie, and N. Garbrah-Aidoo. 2007. Health in our hands, but not in our heads: Understanding hygiene motivation in Ghana. *Health Policy and Planning* 22 (4): 225–233.
- Simmance, F.A., P.J. Cohen, C. Huchery, S. Sutcliffe, S. Suri, X. Tezzo, S.H. Thilsted, et al. 2021. Nudging fisheries and aquaculture research towards food systems. *Fish and Fisheries* 23: 34–53.
- Sumberg, J., J. Jatoe, U. Kleih, and J. Flynn. 2016. Ghana's evolving protein economy. *Food Security* 8 (5): 909–920.
- Svarstad, H., T.A. Benjaminsen, and R. Overå. 2018. Power theories in political ecology. *Journal of Political Ecology* 25: 350–363.
- Teklemariam, A.D., F. Tessema, and T. Abayneh. 2015. Review on evaluation of safety of fish and fish products. *International Journal of Fisheries and Aquatic Studies* 3 (2): 111–117.
- Thilsted, S.H., N. Roos, and N. Hassan. 1997. The role of small indigenous fish species in food and nutrition security in Bangladesh. *Naga* 20 (3–4): 82–84.
- Vercrujssse, E. 1984. *The penetration of capitalism. A West African case study*. London: Zed Books.

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