# Original Research Article

# Perspectives on fish consumption preference, frequency and information accessibility among households in Juba, South Sudan


## ABSTRACT

Eating healthy requires nutritious foods (e.g. fish, vegetables and fruits etc.) on the menu to help improve the health of consumers. As an example of highly nutritious foods, eating fish has the potential to improve human health. Most fish consumption studies mainly focus on consumers' perspectives to evaluate their knowledge and behavior, and are often compared to scientific evidences. In many developing countries, fish consumption cannot only be influenced by consumers' knowledge and behavior but also by other factors such as undersupply of fish and fish products due to poor infrastructures, political instability and unregulated prices in the local markets, accessible and preferred purchasing points, accessible and preferred sources of information, and trust towards agents of information, which are not commonly studied or underrated in developed nations. Limited number of studies only incorporated a few of these variables to understand issues influencing fish consumption. In Juba Town, Kator and Munuki Payams of Juba County and South Sudan at large, recent estimates about food insufficiency among households are worrying. Besides such worsening food insufficiency, studies on food consumption preference, frequency and other persuasive issues have not been conducted or lacking. As a result, this study evaluated perspectives of fish consumption preference, frequency and information accessibility among households in Juba, South Sudan. A total of 191 respondents from Juba Town, Kator and Munuki Payams of Juba County were interviewed using non-probability sampling method. The data were analyzed thematically and descriptively using SPSS software 20.0. Majority of the households (>50%) in Juba consumed fish regularly but in small amounts. The findings also revealed the most preferred fish species and products, purchasing points, motivation and constraints, and information accessibility influencing fish consumption and recommendations for further studies.



*Keywords: Fish consumption; wild-captured fish; farmed fish; imported fish; information sources; information agents; Juba; South Sudan*


## 1. INTRODUCTION

Eating healthy is unfulfilling without nutritious foods (e.g. fish, vegetables and fruits etc.) on the menu to help improve the health of consumers. As an example of highly nutritious foods, eating fish has the potential to improve human health. Fish global annual production was estimated at approximately 96.4 million tons from capture fisheries and 114.5 million tons from aquaculture [1] which only accounted for consumption of 17 percent of the total animal protein and 7 percent of all proteins. According to the Food and Agriculture Organization of the United Nations or FAO [1], more than 70 percent of fish produced worldwide are utilized for direct human consumption compared to other uses such as baits or ingredients in feed formulations, etc. The trend of fish consumption continues to rise at an average annual growth rate of 3.1 percent with an estimated per capita consumption of about 20.5 kg.

In Africa, total food-fish consumption accounted for 12.4 million tonnes live weight equivalent with an estimated 9.9 kg/year per capita food-fish consumption at an increasing rate of 1.3 percent [1]. Consumption of imported fish in Africa accounted for 35 percent. In the East African Community, where South Sudan is currently a member state since 2016, fish consumption is believed to account for 5 kg per capita. Although fish consumption is characterized by unfading supply

deficits (i.e. an issue of the past, now and may still persist in the nearest future) and low per capita intake in East Africa, the proportion of animal protein intake remained low compared to global average [2]. The contribution of fish is nutritionally predominantly more significant when it comes to high-quality animal protein, rich omega-3 (n-3) polyunsaturated fatty acids (PUFA) and fundamental micronutrients needed for healthy growth and development. Consumption of n-3 PUFA, at least once per week, helps in limiting the development of arrhythmias and formation of atherosclerotic plagues and reducing the risk of diseases such as cardiovascular diseases (CVD) [3-6] and many other causes of mortalities [7]. An estimated amount of maximally 3 g/d of n-3 PUFA has previously been recommended by the Food and Nutrition Board [8]. When even eaten in small quantities, fish can help reduce mortality risk from coronary heart disease by 3.9% to 17% and nonfatal myocardial infarction risk by 27% [6]. For each 20 g/day increase in fish consumption, relative risk for coronary heart disease mortality decreases between 5.5% and 7%, considering one serving (100 gram of fish) per week. Nonetheless, it is not possible to determine how changes in the type of fish that people consumed might harm their health. Therefore, knowing consumers' levels of education is also important because of its influence on their perceptions about health benefits and risks associated with fish consumption [9]. Even if not all consumers are knowledgeable about the relationship between n-3 PUFA and human health benefits among other positive contributions, it is believed that their education [10] as well as accessibility and trust on reliability of awareness information [11] could help improve their perceptions about fish and fish consumption.

Generally, fish meat represents an important source of animal protein for better human health performance. Health effect of fish consumption is mostly viewed in terms of the type of fish consumed, meal size, and consumption frequency [12], though the risk of stroke incidence [3] and methyl mercury contamination [13,14] among other complications are probable incidences that may arise. Attitude and desire to consume fish and fish products are additional important factors that cannot be underrated. Consumer attitude and desire to buy fish as food are influenced by the general state of the fish and fish product, price in the market, imported or locally harvested, and farmed or wild-capture fish and others [1,15,16]. The use of hormones and antibiotics in aquaculture facilities and the general condition of processing plants are other concerns that can negatively affect consumption frequency and preference of fish and fish products [17]. Furthermore, consumers' employment status, geographical location as well as traditional beliefs are additional factors that might also influence their desire to eat fish and fish products.

In many developing countries, fish consumption cannot only be influenced by consumers' knowledge and behavior but also by other factors such as undersupply of fish and fish products due to poor infrastructures, political instability and unregulated prices in the local markets, accessible and preferred purchasing points, accessible and preferred sources of information, and understanding the most trusted agents of information to help boost consumers' confidence, which are not commonly studied or underrated in developed nations. Limited number of studies only incorporated a few of these variables to understand issues influencing fish consumption. Unavailability of sufficient food among households is another major issue of concern in developing nations. The prevalence of food insecurity and/or insufficiency have been reported in South Sudan. It was estimated that above 50 percent of the population in South Sudan needed food assistance because they were on the brink of food insecurity crisis [18,19]. Such an estimate nearly doubled from 34 percent previously reported in 2015 [20]. In Juba Town, Kator and Munuki Payams of Juba County, more than 65 percent of people do not have sufficient food available in their households [21]. These are intriguing food insecurity and/or insufficiency indications that require in-depth investigations and palliative interventions or support. Food insecurity is generally caused by many factors, including the adverse impact of flooding, lack of access to healthy food, pressure of increasing population, conflicts and instability, skyrocketing food prices, inequalities, poverty, COVID-19 pandemic etc. [18,19,1]. Understanding consumers' access to adequate availability of nutritious food [22], including fish consumption preference, frequency [23] and patterns [24], is vital in setting the pace for more attention to policy-driven interventions and investments in fish production, supply/value chain, and nutrition extension education to help address food insecurity or insufficiency and improve access to fish and fish products for dietary diversity and income. Besides recent revelation of worrying food insufficiency among households in Juba Town, Kator and Munuki Payams of Juba County and food insecurity in South Sudan at large, studies on fish consumption preference (e.g. fresh versus other fish products, wild versus farmed fish, locally produced versus imported), frequency and other persuasive issues have not been conducted or lacking. As a result, this study evaluated perspectives on fish consumption preference, frequency and information accessibility among households in Juba, South Sudan. Generally, the study answered the following questions. What are the preferred fish species and consumption frequencies of fish and fish products in Juba? What are the preferred sources of fish (e.g. place of purchase, wild versus farmed, locally produced versus imported) by households in Juba? What are the factors influencing consumption of fish and fish products among households in Juba? What are the accessible, preferred and reliable sources and agents of information concerning fish and fish consumption in Juba? The relationship between fish consumption frequency and employment status of the respondents was also tested. Sharing such research findings with the public may help provide a better understanding about access to nutritious food and the need for more attention to policy-driven interventions and investments in fish production, supply/value chain, and nutrition education. This study also briefly provided guidance for establishment of preference-driven fish businesses in Juba, South Sudan.

## 2. MATERIAL AND METHODS

### 2.1 Study area

The study was conducted in Juba, the state capital of Central Equatoria State, and the national capital city of the Republic of South Sudan after independence from the Republic of Sudan in 2011. Based on administrative boundaries, the Republic of South Sudan has 10 States headed by Governors which are further subdivided administratively into 80 Counties and 523 Payams headed by County Commissioners and Payam Directors [25]. Quarter Councils, headed by Chairpersons or Chiefs or Sultans, are administrative subdivisions of Payams (Table 1). Juba, under Juba County in Central Equatoria State, is also the main commercial center and city in the Republic of South Sudan.

**Table 1. Quarter councils in Juba Town, Kator and Munuki Payams in Juba County.**

| **Juba Town Quarter Councils** *under Eastern, Northern, and Southern Zones* | **Kator Quarter Councils** *under Konyokonyo, Malakia, Atlabara, Jebel, Lologo-Kator Zones* | **Munuki Quarter Councils** *under Munuki, Gudele, Rockcity-Jebel, and Nyakuron Zones* |
|---|---|---|
| 1. Hai Gabat | 1. Hai Atlabara Block A | 1. Hai Munuki Block A |
| 2. Hai Jallaba | 2. Hai Atlabara Block B | 2. Hai Munuki Block B |
| 3. Hai Jerusalem | 3. Hai Atlabara Block C | 3. Hai Munuki Block C |
| 4. Hai Juba Na-Bari East | 4. Hai Kosti | 4. Hai Kuwait |
| 5. Hai Juba Na-Bari West | 5. Hai Joborona | 5. Hai Munuki Island |
| 6. Hai Cinema | 6. Hai Kator West | 6. Hai Dar El Salam |
| 7. Hai Malakal | 7. Hai Kator East | 7. Hai Nyakuron Block 1 (East) |
| 8. Hai Nimra Talata | 8. Hai Kator Center | 8. Hai Nyakuron Block 3 (West) |
| 9. Hai Commercial | 9. Hai Kator South | 9. Hai Nyakuron South |
| 10. Hai Mayo | 10. Hai Malakia | 10. Hai Mauna Block 1 |
| 11. Hai Gem | 11. Hai Kassava | 11. Hai Mauna Block 2 |
| 12. Hai Neem | 12. Hai Khor Woliang | 12. Hai Mauna Block 3 |
| 13. Hai Negli | 13. Hai Khelibalak | 13. Hai Gudele Block 4 |
| 14. Hai Zendia | 14. Hai Nyakuron West/East | 14. Hai Gudele Block 5 |
| 15. Hai Thoura East | 15. Hai Gwongoroki | 15. Hai Gudele Block 6 |
| 16. Hai Thoura West | 16. Hai Mijiki | 16. Hai Gudele Block 7 |
| 17. Hai Buluk | 17. Hai Lologo North | 17. Hai Gudele Block 8 |
| | 18. Hai Lologo Center | 18. Hai Gudele Block 9 |
| | 19. Hai Zuhur Fateh | |

Source: field data/Payams' Administrations (*Note: Hai Gudele Block 1, 2 and 3 have been moved under Luri County*).

According to the 2010 statistical yearbook for Southern Sudan [25], the population of South Sudanese was estimated around 8,260,490. Juba County alone has an estimated population of about 368,436 in all its 16 Payams (i.e. Juba Town, Kator, Munuki, Northern Bari, Rejaf, Gondokoro, Bungu, Dolo, Lirya, Ganji, Lokiliri, Lobonok, Mangala South, Rokon, Tijor, and Wonduruba). The populations estimated in Juba Town, Kator and Munuki Payams were about 82,346; 64,130; and 83,719 respectively. But published statistics on the populations at the levels of Quarter Councils were not accessible. Influenced by budget limitation, only three Quarter Councils were selected within the urban settlements of Juba Town, Kator and Munuki Payams using simple random sampling technique. The three study areas were Hai Juba Na-Bari East/West Quarter Council in Juba Town Payam, Hai Gwongoroki Quarter Council in Kator Payam, and Hai Munuki Block "B" Quarter Council in Munuki Payam. For Hai Juba Na-Bari Quarter Council (East and West, both under one Chairperson/Chief), most of the households interviewed were from Hai Juba Na-Bari West, with less than 10 households from Hai Juba Na-Bari East. Prior to kickoff of the data collection, sites visits were carried out in the study areas to help identify potential number of respondents as well as completion of all the necessary administrative arrangements, including processing of permits from the three Payams' authorities and nomination of one Payam administrator (e.g. an Executive/Officer) per each Chairperson/Chief of the three selected Quarter Councils or their representatives to facilitate data collection in the three Quarter Councils.

### 2.2 Sampling design and data collection

The questionnaire for this study was designed according to Alosias [26]. In the design, the questions asked during the interviews with respondents were constructed in the forms of opened-and-closed-ended, Likert-scale types, and Trichotomous-choice questions. Both quantitative and qualitative data, using non-probability sampling method, were collected from the households in Hai Juba Na-Bari East/West, Hai Gwongoroki and Hai Munuki Block "B" Quarter

Councils. The quantitative data involved questions that generated numerical data (*e.g. What is your total number in the household? From the following consumption scales, please select the quantity of fish in kilograms consumed in one household meal per day, and please insert a complete figure*). The qualitative data involved questions that generated data in the forms of identities, reasons, descriptions or comments (*e.g. Please list your top-5 fish species consumed more frequently in your household, sequentially starting with 1st choice, and explain briefly your reasons. Please explain, briefly, your reasons why you scored some fish species as not preferred.*). The findings of this study were presented thematically and descriptively. Furthermore, a consent statement in the questionnaire was read to each respondent to ensure voluntary participation, honesty, confidentiality and the right to refuse or accept to participate after a brief introduction on the problem statement and objective of the survey.

The list of fishes, used in Tables 3 and 4, was developed based on an informal unpublished assessment conducted on the dominant genera of fishes in the local markets in South Sudan in 2016 as one of fisheries course materials used for lectures. In this informal study, unlike the complete scientific (genus and species) and local names documented by Bailey [27], all the fishes included in the tables were only identified by their generic names simply because some genera have more than one species of fish and could consequently create a longer list of fish species. Consumer preference between two or more species within a genus is an important consideration, though not considered in this survey. But examples of specific fish species found in South Sudan within the generic names listed in Tables 3 and 4 include (local names inside brackets): *Synodontis schall* (Gargur), *Lates niloticus* or Nile perch (Igl or Eegil), *Distichodus niloticus* (Khraish), *Oreochromis niloticus* (Bulti or Khadem mirie), *Clarias gariepinus* (Garmut), *Mormyrus cashive* (Khasm al banat), *Protopterus aethiopicus* (Samak el teen), *Citharinus latus* (Betkoya), *Gymnarchus niloticus* (Wir or Weer), *Auchenoglanis occidentalis* (Humar el hut) or *Bagras docmak* (Kabaroce), *Heterotis niloticus* (Nauk or Nok), *Labeo niloticus* (Dabs), and *Alestes dentex* (Kawwara baladi or Characin) [27].

Months before the field data collection at the households, preliminary information on the existing Quarter Councils and their respective Chairpersons/Chiefs were collected from the Payams' Administrations. These records were obtained from the Clerical Office with approval via the Office of the Director in the three Payams. Prior to the field data collection, field enumerators were trained on the 18th March 2020, followed by another refresher training on the 3rd June 2021 after the resumption of restricted public gatherings because of the interruptions from the COVID-19 pandemic. A total of 191 respondents from Hai Juba Na-Bari (34.6%), Hai Gwongoroki (33.5%) and Hai Munuki Block "B" (31.9%) Quarter Councils were interviewed. According to the plan, the data collection lasted for a period of three weeks (i.e. five days in each Payam: Wednesday thru Sunday, excluding Monday and Tuesday as a break) starting from 16th - 20th June 2021 in Juba Town Payam, 23rd - 27th June 2021 in Kator Payam, through 30th June – 4th July 2021 in Munuki Payam between 8:00 and 17:00 hours, including one-hour lunch break from 12:00 to 13:00. Monday and Tuesday were used as a 2-day break for handling related administrative arrangements (e.g. remuneration of the facilitators and enumerators, preparation for the next study area etc.) simply because it was assumed that they were the busiest days of the week for employed respondents. Such a break might also create a balance in availability of respondents for interview between employed and self-employed respondents because Friday through Sunday could also be the busiest days for self-employed respondents.

Any person found available at home during the data collection, whether the head of the household or related family member, whose age is greater than or equal to 20 years-old but not above 79 years-old and happened to buy fish or involved in decisions to buy fish for consumption in the household, was considered an eligible participant that met the criteria of a respondent for this survey. In some days, the facilitators used to mobilize between 3 and 5 respondents in one location and they were interviewed one after the other. For example, about 2-4 representatives of individual neighboring households were mobilized in a house of one respondent. Consequently, GPS coordinates cannot be recorded for those who came as representatives of individual neighboring households. All the coordinates were recorded using Digital Compass App version 7.7 for Android developed by KTW Apps, Jalan Bukit Kristal 23, Taman Bukit Kristal, Seremban, Negeri Sembilan, Malaysia.

In addition to investigating preferred fish species and issues often motivating or limiting consumers' desire to buy and eat fish, respondents were asked to rate their accessible and preferred place of purchasing fish and fish products as similarly reported by Laguna et al. [28]. All Likert-scale questions were rated using a seven-(7)-point scale with slight variations in the words measuring respondents' desires. For example, there were Likert-scale questions measuring preference (7=strongly preferred & 1=strongly not preferred), accessibility, severity and reliability etc. The places for purchasing fish include local markets, supermarkets, and mobile sellers among others. They were also asked about their perceived reliability of fish consumption advices or information from 10 agents of information (e.g. politicians, health personnel, academicians, religious servants, etc.). With regard to information accessibility, respondents were asked to rate their accessible and preferred sources of information about fish and fish consumption (e.g. television, social media, radio, friend etc.) and reliability of agents of information (e.g. politicians, health personnel, academicians etc.).

### 2.3 Data analyses

The variables used in this study were categorized under four themes: namely (1) demographic characteristics of the respondents, (2) behavioral characteristics toward fish consumption, (3) consumption preference and frequency, and (4)

information accessibility about fish and fish consumption among households in Juba. By looking through these themes, this study might help provide a better understanding about access to nutritious food and the need for more attention to policy-driven interventions and investments in fish production, supply/value chain, and nutrition education.
Analyses of the responses collected from the respondents were performed according to Alosias [26]. Similarly, tables and charts were used to depict descriptive findings from the data. Furthermore, a Chi-square test was employed at 5% significance level to test an alternative hypothesis using occupation and FCF as variables (FCF means Fish Consumption Frequency) to examine the relationship between employment status of the respondents and the frequencies of fish consumption in their households using the SPSS software version 20.0.

## 3. RESULTS AND DISCUSSION

### 3.1 Demographic characteristics of respondents

The demographic characteristics of respondents interviewed during this survey showed that majority (78%) of the total sample size were female, of which 58.4 percent represented by spouses (Table 2). The percentage of males was 22. Such a low percentage of male participation might reflect low responsiveness from men and high responsiveness from women in voluntary response survey. Nevertheless, some heads of the households found during the data collection prefer to assign their wives and/or elder daughters to answer the survey questions, while they only listen to the interview or depart to attend to other commitments. This also contributed to the domination of female respondents in this survey.

**Table 2. Demographic characteristics of respondents interviewed in Juba Town, Kator and Munuki Payams by category, number and percentage (%, *n* = 191; field data).**

| Category | | | Number | % |
|---|---|---|---|---|
| **Gender** | Female | South Sudanese | 148 | 77.5 |
| | | Sudanese | 0 | 0.0 |
| | | Ugandan | 1 | 0.0 |
| | | Kenyan | 0 | 0.0 |
| | | Other | 0 | 0.0 |
| | | Sub-total | 149 | 78 |
| | Male | South Sudanese | 41 | 21.5 |
| | | Sudanese | 1 | 0.0 |
| | | Ugandan | 0 | 0.0 |
| | | Kenyan | 0 | 0.0 |
| | | Other | 0 | 0.0 |
| | | Sub-total | 42 | 22 |
| | Total | | 191 | 100 |
| **Age** | 20 – 29 | | 74 | 38.7 |
| | 30 – 39 | | 54 | 28.3 |
| | 40 – 49 | | 30 | 15.7 |
| | 50 – 59 | | 14 | 7.3 |
| | 60 – 69 | | 11 | 5.8 |
| | 70 – 79 | | 8 | 4.2 |
| | Total | | 191 | 100 |
| **Relationship in the household** | Head | | 71 | 37.2 |
| | Spouse | | 85 | 44.5 |
| | Son/daughter | | 27 | 14.1 |
| | Spouse of son | | 2 | 1.0 |
| | Grandchild | | 0 | 0.0 |
| | Brother/sister | | 2 | 1.0 |
| | Brother/sister in-law | | 1 | 0.5 |
| | Parent | | 0 | 0.0 |
| | Parent in-law | | 0 | 0.0 |
| | Niece/nephew | | 1 | 0.5 |
| | Other | | 2 | 1.0 |
| | Total | | 191 | 100 |
| **Number of people in** | Less than 3 members | | 6 | 3.1 |
| | 3 – 7 members | | 78 | 40.8 |

| | | | |
|---|---|---|---|
| **the household** | More than 7 members | 107 | 56.0 |
| | Total | 191 | 100 |
| **Household composition** | Single person household | 2 | 1.0 |
| | Married without children | 3 | 1.6 |
| | Married with children | 107 | 56.0 |
| | Living with parents | 24 | 12.6 |
| | Living with extended family | 5 | 2.6 |
| | Living in a shared household, not related | 9 | 4.7 |
| | Other | 41 | 21.5 |
| | Total | 191 | 100 |
| **Marital status** | Single | 15 | 7.9 |
| | Engaged | 9 | 4.7 |
| | Married | 116 | 60.7 |
| | Widow | 26 | 13.6 |
| | Widower | 1 | 0.5 |
| | Separated | 18 | 9.4 |
| | Divorced | 6 | 3.1 |
| | Other | 0 | 0.0 |
| | Total | 191 | 100 |
| **Level of Education** | No formal education | 39 | 20.4 |
| | Bush school education | 2 | 1.0 |
| | Primary school education | 70 | 36.6 |
| | Secondary school education | 59 | 30.9 |
| | Diploma (< 4 years) | 13 | 6.8 |
| | Bachelor (>= 4 years) | 8 | 4.2 |
| | Postgraduate (Master/Doctorate) | 0 | 0.0 |
| | Other | 0 | 0.0 |
| | Total | 191 | 100 |
| **Occupation** | Not employed | 79 | 41.4 |
| | Self-employed | 93 | 48.7 |
| | Employed | 19 | 9.9 |
| | Total | 191 | 100 |
| **Scale of earning (SSP)** | Less than 1,000 | 81 | 42.4 |
| | 1,000 - 4,999 | 12 | 6.3 |
| | 5,000 – 9,999 | 19 | 9.9 |
| | 10,000 – 15,000 | 23 | 12.0 |
| | More than 15,000 | 56 | 29.3 |
| | Total | 191 | 100 |

*Other nationality* means foreign nationalities apart from Sudanese, Kenyan and Ugandan. *Other household composition* include widow with children; separated with children/child; divorced with children; engaged with children; living with in-law/family member or in child's house.

### 3.2 Behavioral characteristics toward fish consumption

Respondents in this study have shown some behavioral characteristics with regard to fish choice and fish consumption. In Figure 1, majority of the respondents (87.4%) interviewed were participating in buying and eating fish. It showed that more than 90 percent ($n$ = 174) of the households were able to afford to buy fish. This finding is a confirmation of the fact that people living in urban cities have more disposable income allowing them to access fish protein among other animal proteins [1]. Unlike in rural settlement, fish and fish products are increasingly sold in urban areas because of better infrastructures that always help, as an additional advantage, in facilitating improvement in storage, transportation and marketing opportunities (etc.). None of the respondents were found in the category of those who don't buy fish and don't eat fish. The category 'I don't buy fish but I eat fish' is mainly selected by a member of the household who doesn't participate in buying fish for consumption in the household (i.e. he/she didn't contribute financially and was even not sent to go and buy fish before) but he/she eats fish when bought and prepared by the other household members.

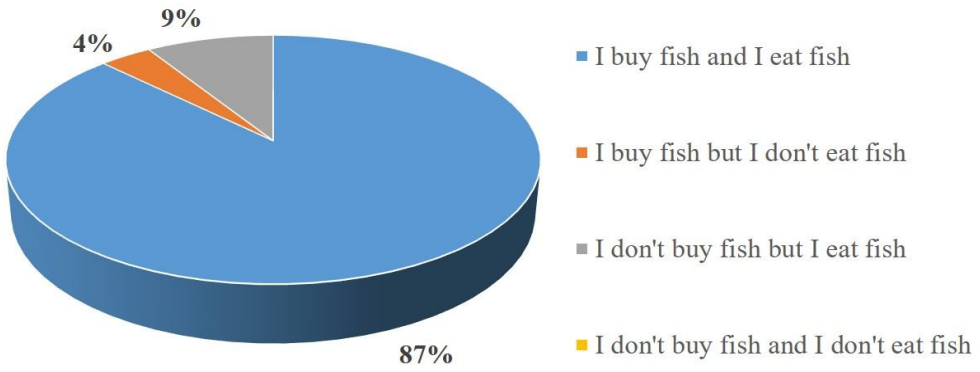


**Fig. 1. Percentages of respondents involved in buying and eating fish (%, n=191; field data)**

With regard to respondents' desires to eat fish, four reasons were prescribed as examples of major reasons that could help explore their motivations. The reasons include high nutritional value, taste, traditionally/culturally dominant food, and cheap source of animal protein (Figure 2). Other means other examples of respondents' desires to eat fish, apart from the four prescribed reasons. It was found that most of the respondents agreed with the four variables selected to underscore their motivations to eat fish. Taste (> 90%) of fish and fish products was the dominant reason why respondents in this study buy and eat fish, followed by high nutritional value. Thus, their desires or reasons to buy and eat fish have generally been motivated by the taste (93.1%) and nutritional value (92.1%) of fish and fish products. All respondents (100% black in Figure 2) did not mention additional reasons as desires for them to eat fish (Other in Figure 2), apart from the four prescribed reasons. Similar to other nutritious foods, respondents believed that fish consumption provides some nutritional values to human health, though in general without specific examples. Specific examples of high nutritional values include provision of n-3 PUFA, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) needed for brain development and body health improvement as well as vitamin D for bone mineralization, and vitamins A, E, B1, B2, B6, B12 and Folate [29-32,4] among other benefits. The nutritional valuations and benefits of eating fish are many.

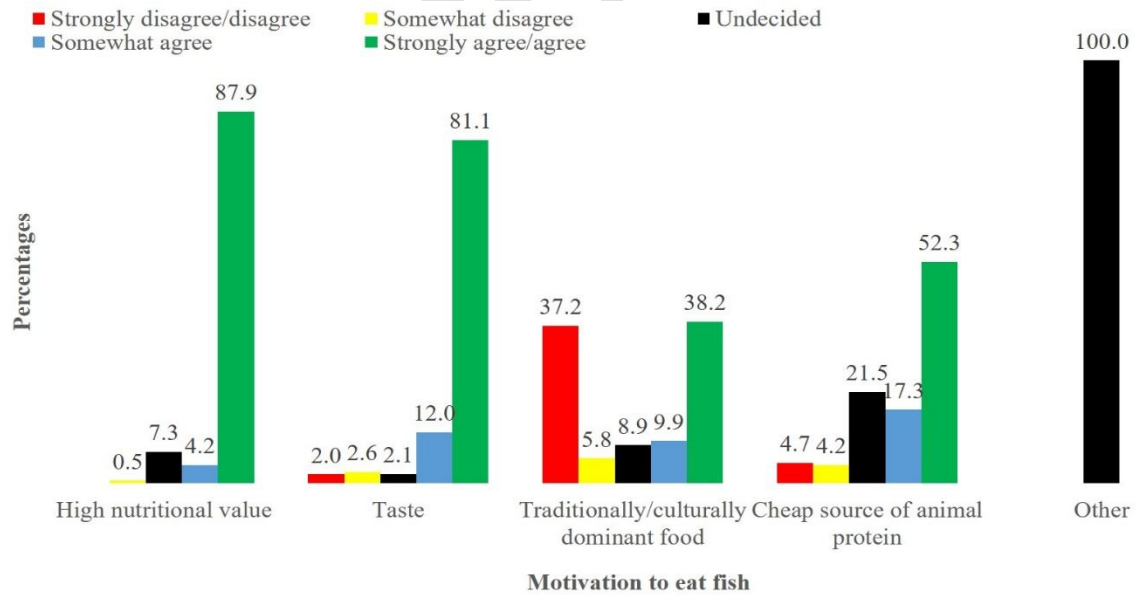


**Fig. 2. Percentages of respondents in relation to their desires to eat fish (%, n=191; field data)**

Sharing these brief examples is crucial for South Sudanese (and those in other developing countries) who were not aware of such specific nutritional values that can be acquired when they eat fish. Consequently, people who were not eating fish, just due to a lack of awareness of these summarized important nutritional values, may start doing so. In a prospective birth cohort study that investigated the association between fish consumption during the first year of life and development

of allergic diseases by age four [33], as an additional example of nutritional values of fish consumption, the finding revealed that regular fish consumption before age 1 appears to be associated with a reduced risk of allergic disease and sensitization to food and inhalant allergens during the first 4 years of life. When consumed at least twice per month during the first year of life [33], fish also helps in limiting the risk of people developing asthma, eczema, allergic rhinitis and sensitization.

In addition, more than 50 percent of the respondents in this survey also considered fish as a cheap source of animal protein compared to other sources of animal proteins such as chicken and beef among others. Around 43 percent of the respondents has not bought and ate fish as a traditionally or culturally dominant food simply because fish has not been listed or known as one of their culturally or traditionally dominant foods.

Generally, the prevalence of positive image of fish, reinforced by its ideal nutritional valuation attributes, have been reported [34-38]. Fish is always commended for its nutritional contents. Regardless of such positive attitude, the need for balanced information on the awareness of both potential benefits and risks associated with fish consumption is so crucial. One of the best ways to improve consumers' awareness with regards to potential benefits and risks associated with fish consumption is by strengthening academia-lead outreach or extension programs through workshops, seminars or on-air extension education. Successful implementation of academia-lead extension programs on consumer knowledge and healthy food for nutrition education do not exclude producers, food actors and public authorities [34] that does not only emphasize nutritional benefits but also help to improve self-confidence in valuation of fish quality and other benefits beyond health-related concerns, including enlightenment on potential allergic health complications as underscored in Figure 6.

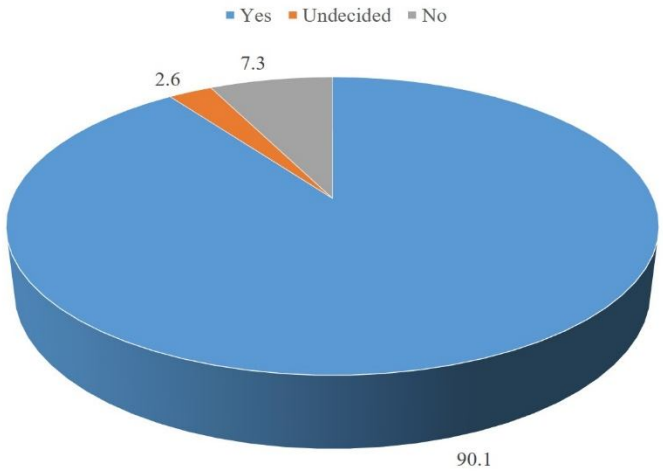


**Fig. 3. Percentages of respondents' willingness to recommend others to buy and eat fish (%, n=191; field data)**

The willingness of respondents to recommend others to buy and eat fish has also been assessed. As shown in Figure 3, majority of respondents (90.1%) positively expressed their desire to recommend others to buy and eat fish. They believed that everyone should benefit from the nutritional richness found in fish and fish products. Only about 7.3 percent of the respondents did not like to recommend others to buy and eat fish. While some respondents felt that fish is expensive, others fear the unknown health complications that may arise; in the case of allergic reactions, for example. Less than 4% of the respondents were not sure whether recommending others to buy and eat fish is a good idea or not.

## 3.3 Fish preference and consumption frequency

A list of 13 fish species commonly found in the local markets here in Juba, with their respective pictures, was shown to all the survey respondents to identify those they prefer to buy and eat in their households. Their responses were summarized in Table 3.

A score comparison of respondents' consumption preferences among the dominant fish species in the local markets here in Juba revealed some differences. On the one end, tilapia appeared to be the most preferred fish as it received more than 95% preference score. Reasons associated with such high preference score from the respondents towards tilapia include its taste and frequent recommendations from nutritionists and/or medical personnel for sick patients to get vitamins and other nutrients to help them recover from their sicknesses. Apart from tilapia, consumption preferences also vary among the other remaining twelve fish species on the prescribed list of common fish and fish products found in the local markets in Juba.

**Table 3. Percentages of respondents' preferences toward selected species of fish, type of fish products and generalized source of fish and fish products (%, n = 191; field data).**

| Category | Strongly not preferred/ not preferred | Somewhat not preferred | Undecided | Somewhat preferred | Strongly preferred/ Preferred |
|---|---|---|---|---|---|
| ***Fish species*** | | | | | |
| Synodontis | 16.2 | 4.7 | 2.6 | 12 | 64.4 |
| Perch | 11 | 0.5 | 3.7 | 19.4 | 65.4 |
| Distichodus | 9.4 | 2.6 | 2.1 | 16.8 | 69.1 |
| Tilapia | 1.6 | 1.6 | 0.5 | 4.2 | 92.1 |
| Clarias | 29.3 | 5.8 | 1 | 11.5 | 52.4 |
| Mormyrus | 14.7 | 4.2 | 3.1 | 17.3 | 60.7 |
| Protopterus | 64.9 | 3.7 | 6.3 | 8.4 | 16.8 |
| Citherinus | 11 | 3.7 | 9.4 | 18.8 | 57.1 |
| Gymnarchus | 18.3 | 3.1 | 8.4 | 22 | 48.2 |
| Auchenoglanis | 12.6 | 7.9 | 4.2 | 15.2 | 60.2 |
| Heterotis | 27.7 | 8.4 | 7.3 | 18.3 | 38.2 |
| Labeo | 11.5 | 3.7 | 6.3 | 19.4 | 59.2 |
| Alestes | 11.5 | 3.1 | 2.1 | 18.3 | 64.9 |
| *Other: H. forskhalii* | | | | | 0.5 |
| *Other: Keje fish* | | | | | 1.6 |
| *Other: M. electricus* | | | | | 0.5 |
| ***Fish product*** | | | | | |
| Fresh fish | 0.5 | 0.0 | 0.0 | 0.0 | 99.5 |
| Frozen fish | 50.3 | 4.2 | 3.1 | 23.0 | 19.4 |
| Sundried fish | 26.7 | 6.3 | 0.5 | 23.6 | 42.9 |
| Smoked fish | 5.2 | 2.1 | 1.6 | 7.9 | 83.2 |
| Salted fish | 34.6 | 7.3 | 2.1 | 15.2 | 40.8 |
| Fermented fish | 71.2 | 1.6 | 9.9 | 4.2 | 13.1 |
| Canned fish | 33.5 | 3.1 | 4.2 | 11.0 | 48.2 |
| ***Generalized source of fish*** | | | | | |
| Locally wild-captured | 0.5 | 0.0 | 0.0 | 0.0 | 99.5 |
| Locally farmed | 23.0 | 3.7 | 4.2 | 16.2 | 52.9 |
| Imported wild-captured | 56.0 | 5.8 | 3.1 | 22.5 | 12.6 |
| Imported farmed | 61.8 | 5.2 | 3.1 | 18.3 | 11.5 |

Sequentially, the other preferred fish species after tilapia begin with Distichodus (85.9%), Perch (84.8%), Alestes (83.2%), Labeo (78.6%), Mormyrus (78%), Synodontis (76.4%), Citherinus (75.9%), Auchenoglanis & Bayad (75.4%), Gymnarchus (70.2%), Clarias (63.9%), and ends with Heterotis (56.2%). On the other end, Protopterus appeared to be the only fish species preferred by a fewer respondents as it scored 25.2 percent. Keje fish is another example of small fish preferred by some respondents. The name keje fish is another local name for small-size dried fish, commonly known as dagaa or omena or mukene (*Rastrineobola argentea*), used by consumers here in South Sudan. It is one of the most plentifully harvested small-size fish species in Lake Victoria that was categorized as nutrient-rich, available, acceptable and affordable for human consumption [39-41] widely across the globe. As an example of small-size fish species with most of its micronutrients mainly concentrated in the bones and heads among others [42], eating keje fish as whole provides a very rich source of highly bioavailable calcium possibly needed for bone mineralization in human body. Consumption of keje fish is common among poor people and is also considered as one of the favorite food supplements or dishes always recommended for malnourished children in the local hospitals and health centers here in South Sudan. Generally, small-

size fish species, categorized below 10 cm long, are nutrient-rich source of animal protein [43]. They are usually eaten whole and equally distributed among family members during meal time compared to big-size fish species. If processed into dried fish powder, consumption of small quantity of such a product from locally available small-size fish species as part of daily meal can achieve a greater density of iron, zinc, calcium and docosahexaenoic acid needed to combat nutrient deficiencies and improve meal quality in the first 1000 days after birth [44].

With regards to the types of fish products (Table 3), fresh fish was the most preferred fish product by almost all respondents (99.5%) in this study. Smoked fish was the second most preferred fish product (83.2%). But some respondents also prefer to buy and eat the other types of fish products such as canned fish (48.2%), sundried fish (42.9%), salted fish (40.8%), frozen fish (19.4%) and even fermented fish (13.1%) products. Unlike fresh fish, cured fish products (e.g. smoked, salted, fermented etc.) are often mixed and cooked in combination with other food materials to produce some locally preferred foods in the households and even local restaurants. Mula-Juwa (i.e. a complete dish cooked after fresh fish is kept in a pot containing salted water to ferment for not less than 24 hours, then cooked together with flour porridge etc., after the bones were entirely removed; common in Terekeka County) is an example of a locally preferred food from such a combination. Kombo-Samak (i.e. dried fish cooked with okra and peanut butter, and eaten with stiff flour porridge; common in Juba County) is another example. Similar practices were common in other countries as well [42], where cured fish products are usually cooked as a mixed curry or stew dish with vegetables and spices.

In terms of generalized sources of fish supply to the local markets (e.g. local fish production and importation), there were variations in respondents' beliefs (Table 3). Almost all respondents prefer locally wild-captured fish (99.5%). The percentage of those who also prefer locally farmed fish was above 60 percent of the total number of respondents, with some levels of hesitancy. So, most of the households in this study prefer locally wild-captured fish and locally farmed fish unlike imported wild-captured fish and imported farmed fish. Besides wild-captured fish, initiatives to increase the production as well as supply of locally farmed fish to address trade barriers to fish importation for healthy nourishment of the whole population [2,45,46], which has already been initiated in a number of African nations [45], should be encouraged and supported here in South Sudan. Locally sourced fish, whether wild or farmed, were believed to be fresher than imported fish. With such a mindset, households were willing to spend more money on locally harvested or produced fish and fish products than on imported ones. Similar consumer beliefs existed in other countries as well. According to previous studies, consumers were also generally willing to spend more money on locally harvested or produced fish and fish products [47-51]. This was considered not a surprise because of concerns over irregularities in monitoring, inspections and quality assurance systems.

Respondents in this survey were also queried about their desire to buy and eat farmed fish. In Figure 4, their responses were summarized. The results showed that more than 60% of them were willing to buy farmed fish. It is an encouraging indication for fish farming, as South Sudan still struggles to develop its fish farming or aquaculture industry. Knowing the existence of demand for the consumption of farmed fish may help attract more attention and investment into the fish farming or aquaculture industry.

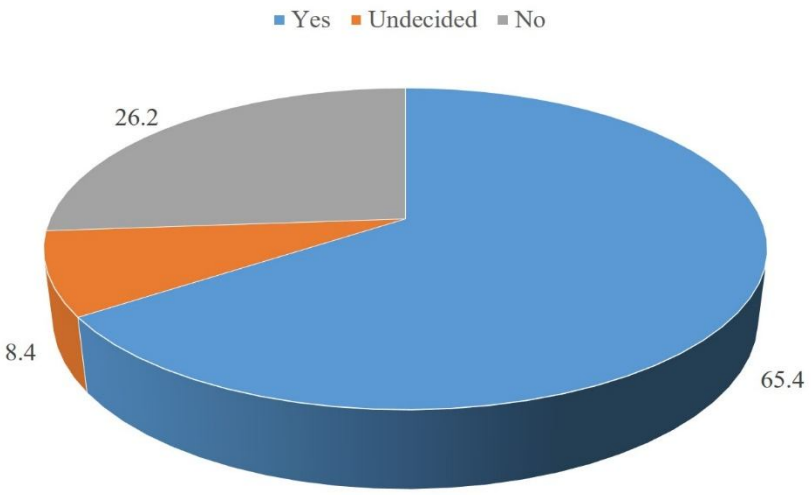


**Fig. 4. Percentages of respondents' desire to buy and eat farmed fish (%, n=191; field data)**

Respondents who do not desire to buy and eat farmed fish highlighted some concerns over substandard issues related aquaculture produces and farming incompetency (e.g. lack of technical trainings on fish farming here in the Republic of South Sudan). Some respondents feared the possibility of the use of drugs and poor quality feed to reduce the cost of farming. Others were worried about the quality of the pond water due to its stagnant nature – arguing that they prefer to

buy and eat fish caught from a running water (e.g. Nile River). Majority of the respondents (> 95%) prefer to eat wild-captured fish compared to those who desire to consume farmed fish (< 70%) (Table 3). A high percentage of consumers in favor of wild-captured fish, and fear over significant concentrations of drugs in farmed fish have similarly been reported by Lopez-Mas et al. [52]. According to the authors, one of the best ways to reflect a positive image of farmed fish is through concerted efforts and awareness programs that emphasize the positive attributes regarding its production and reported nutritional valuations for human consumption. Although perceived concerns raised by respondents over the quality of farmed fish in this survey warrant further investigations and could even jeopardize efforts to develop the aquaculture industry in the Republic of South Sudan, those rejecting to buy and eat farmed fish should be made aware of the positive attributes associated with farmed fish via fish nutrition extension education.

Furthermore, imported wild-captured and imported farmed fish were all scored below 40 percent of the total number of respondents (Table 3). They believed the process of transporting fish from another country often takes longer time than expected. Thus, the quality of imported fish products is expected to degrade and even often not healthy for consumption. Other respondents believed that some traders might also be tempted to use chemicals and substances harmful to human health just to make their fish looks much fresher. According to one of the recent studies [47], as also mentioned earlier, the quality of imported fish and fish products is generally considered less safe than locally harvested or produced fish, often, due to poor or lack of import inspection services. Doubts related to the quality and safety of imported fish products had also previously been documented by other researchers [11,53], in which majority of their respondents were among those not sure and those who do not like imported fish and fish products. Nonetheless, it is still believed that there is room for awareness programs to help educate the public on processes and standards associated with importation of fish and fish products.

As doubts over the quality and safety of imported fish products were still eminent, between 64.9% (imported wild-captured fish) and 70.1% (imported farmed fish) of the respondents with undecided and rejection scores were recorded in this survey (Table 3). Such scores might be associated with lack of or weak inspection programs at the border and in the local markets. Winning their trust may require robust inspection strategies and supported policy frameworks in form of modernized and empowered monitoring system as well as open data sharing in overseeing food quality and safety because most of the quality and safety problems are linked to activities (e.g. handling, processing, distribution etc.) encountered in the fish supply chains [47,54]. As a complementary quality assurance approach to also conquer consumers' mistrust and lack of confidence towards imported fish products, it would be interesting if the attitudes of fish supply/value chain stakeholders or actors and influencers towards probable adoption of fish integrity and information sharing system [55], is studied and tested here in Juba or South Sudan at large.

**Table 4. Percentages of respondents by their top-5 fish species ranking preferred for consumption in household (%, *n* = 191; field data).**

| Name of fish species | Fish species ranking by percentage of respondents | | | | | |
|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | Overall |
| Synodontis | 9.4 | 16.8 | 9.4 | 7.9 | 1.6 | 45.0 |
| Perch | 7.3 | 12.6 | 7.9 | 2.6 | 6.3 | 36.6 |
| Distichodus | 11.5 | 7.9 | 6.3 | 6.3 | 4.7 | 36.6 |
| Tilapia | 50.8 | 17.3 | 11.0 | 2.1 | 4.2 | 85.3 |
| Clarias | 7.3 | 9.9 | 11.5 | 6.8 | 5.2 | 40.8 |
| Mormyrus | 5.8 | 6.8 | 11.0 | 14.1 | 5.8 | 43.5 |
| Protopterus | 0.5 | 1.0 | 1.6 | 0.5 | 1.0 | 4.7 |
| Citherinus | 0.5 | 4.2 | 1.6 | 3.7 | 5.8 | 15.7 |
| Gymnarchus | 0.0 | 3.1 | 5.8 | 5.8 | 4.7 | 19.4 |
| Auchenoglanis | 1.0 | 3.7 | 6.3 | 8.4 | 4.2 | 23.6 |
| Heterotis | 1.0 | 3.1 | 0.5 | 1.6 | 1.0 | 7.3 |
| Labeo | 0.5 | 3.7 | 7.9 | 6.3 | 2.1 | 20.4 |
| Alestes | 3.1 | 6.3 | 7.9 | 7.9 | 6.3 | 31.4 |
| Other: H. forskhalii | 0.0 | 0.0 | 0.5 | 0.0 | 0.5 | 1.0 |
| Other: Keje fish | 0.0 | 1.0 | 0.0 | 0.0 | 0.5 | 1.6 |

With regards to selecting the top-5 ranked fish for consumption in the households, as shown in Table 4, respondents' choices vary. Protopterus, interestingly, appeared in all the five top ranks as a 1st choice by one household, a 2nd choice by two households, a 3rd choice by three households, a 4th choice by one household, and as a 5th choice by two households.

But in terms of high score, Nile tilapia had the highest (>80%) overall rank compared to the rest of the fish species. It, even, carried the highest percentage (50.8%) as the number one choice of fish favored for consumption in the households, followed by Distichodus (9.4%), Perch and Clarias (7.3%), and Mormyrus (5.8%). The choices ranked in this study could be used by producer groups, value chain actors (e.g. processors, traders etc.), researchers as well as development agencies and investors to select or prioritize fish species that were highly valued for business or nutrition-related interventions in Juba. So, based on score preferences, the top-5 fish species among households in this survey were Tilapia (1st choice), Distichodus (2nd choice), Perch and Clarias (3rd & 4th choices), and Mormyrus (5th choice). The results of these top-ranked fish species in Table 3 correspond slightly with fish species preferences in Table 2, showing Tilapia and Distichodus as the top-1 and-2 favored fishes in Juba.

In this study, similar to fish species preference, fish consumption frequency also varies across households. In Figure 5, the results have shown that respondents eat fish thrice per week (2.1%), twice per week (28.8%), once per week (24.6%), thrice per month (1.0%), twice per month (18.8%), once per month (16.8%), while the rest of the respondents (<10%) consumed fish much irregularly or often not even consuming fish for an extended period of time. As such, more than 50 percent of the households in this survey consumed fish thrice, twice or once per week. This result is in disagreement with the United Nations Development Program (UNDP) South Sudan report [21] which reported that only 2 percent of the households in Juba consume fish frequently. It might be considered a good indication because majority of respondents in this survey could be classified as regular fish eaters due to their high consumption scores, albeit small consumption amounts. Regular fish eaters with high consumption scores are consumers who eat fish once or more times per week [11,56], unlike moderate fish eaters who consume fish few times per month as well as infrequent fish eaters who cannot exceed once per month. However, there was no significant statistical difference ($P > 0.05$) between fish consumption frequency and occupation. So, the test failed to reject the null hypothesis. Statistically, there is no relationship between fish consumption frequency and employment status of the respondents.

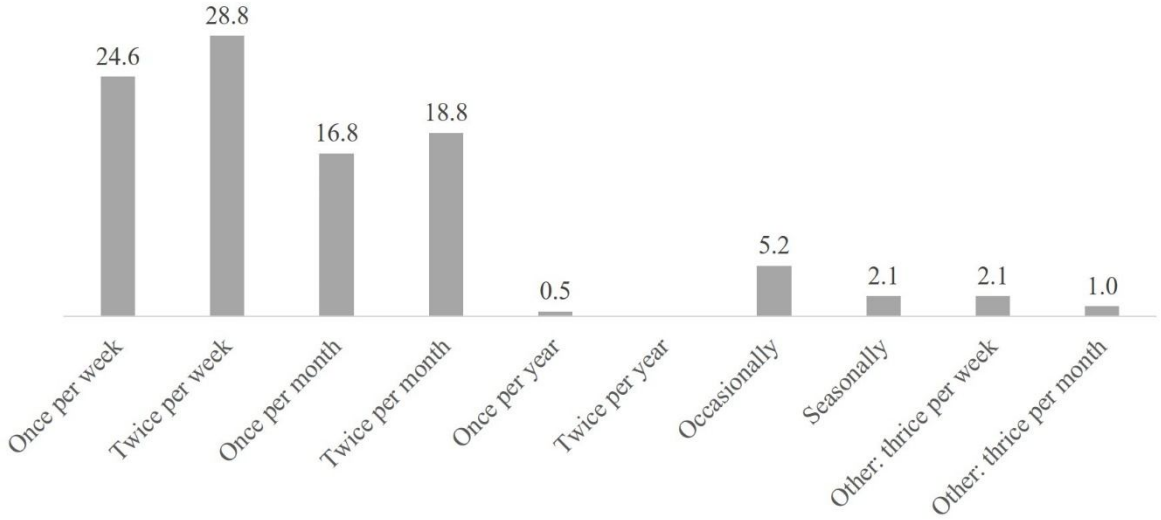


**Fig. 5. Percentages of respondents by frequency of fish consumption in the households (%, n=191; field data)**

With majority of respondents being classified as regular fish eaters in this survey, they may have low risk of coronary heart disease (CHD) mortality, if studied. This is possible because previous research investigations have reported that regular consumption of fatty and even lean fish improves chances of minimizing the rate of death incidents from CHD [5,57-59], even stroke [3,60], general disorders of the heart and blood vessels [61,62] as well as reduced risk of age-related macular degeneration incidences [63,64]. Besides all the aforementioned positive outcomes linked to consumption of fish and fish products, the influences of different levels of long-chain n-3 PUFA across different types of fish species, cooking time/ingredients and ways of estimating adequate quantity of fish that could be used as a standard against different health risks still remain questionable and merit further research investigations.

In addition to the above important positive outcomes, Bennett et al. [65,66] managed to summarize more than four-item list of vital nutritional benefits associated with consumption of fish and fish products. Accordingly, eating fish provides:

a) Vitamin D needed to strengthen our bones, improves the health of a newborn and the mother, and reduces the risk of rickets in children as well as cancer-related risks and autoimmune diseases.
b) Vitamin A needed to reduce the risk of childhood blindness, supports immune system function, and improves the health of a newborn and the mother.
c) Vitamin B12 needed for the maintenance of our body nervous system, enhances growth, and proper brain functions among other possible benefits.

d) Crucial minerals, such as iron, needed for reduction of the risk of anemia; and zinc needed for proper growth and development in children, helping in reducing incidences of diarrhea, pneumonia, and malaria, etc.
e) Other positive effects including enhancement of the quality of breast milk, provision of supplementary micronutrients needed within the first 1000 days of life as well as helping in reducing risks associated with CVD and related complications.

With the above-mentioned nutritional evidences associated with consumption of fish and fish products to improve human health and contribute to global food and nutrition security, efforts to highlight the value of fish consumption as an important nutritional and livelihood discourse is also very crucial in recognizing fish as food in developmental and intervention priorities [65]. This way, in line with development and enforcement of appropriate policies, it may provide strong incentive in positioning fish profile among critically nutritious foods to alleviate food insecurity and/or insufficiency in Juba and South Sudan at large. The drivers of food insecurity, such as lack of access to healthy food and poverty [18,19], recently reported here in South Sudan, could be addressed using fish as an important nutritional and livelihood discourse for consumption and income.

All the respondents were also asked to rate the reasons why they often do not buy and eat fish. The reasons used in this survey were grouped as constraints (Figure 6). They include high price of fish and fish products, under-supply, poor quality, distant market, unpleasant fishy smell, religious restrictions, cultural restrictions, health complications, and other few constraints. Respondents indicated poor quality as the dominant reason (96.3%) among their top-three constraints. High price (76.5%) and under-supply (65.9%) were the other two constraints severely affecting fish consumption in their households. So the reasons why people in Juba, South Sudan, do not buy and eat fish vary. They could be more than the ones prescribed in this study. Similar observations were also reported by Hicks et al. [11]. These constraints could be addressed via tailor-made trainings on the best production practices and improved post-harvest fish handling and processing as well as the use of subsidies in the fish supply/value chain by the states and the national governments in collaboration with relevant stakeholders and development agencies.

In addition to the prescribed list of reasons limiting fish consumption at household level, some respondents reported that the entire household members can stop eating certain fish species or fish products if a member didn't desire to eat or experienced some health complications as a result of eating such species or products. For instance, if a member in the household experienced an allergic reaction from consumption of certain fish species (e.g. *Heterotis niloticus*, commonly reported by some respondents), that particular fish species or product will not be cooked and eaten again.

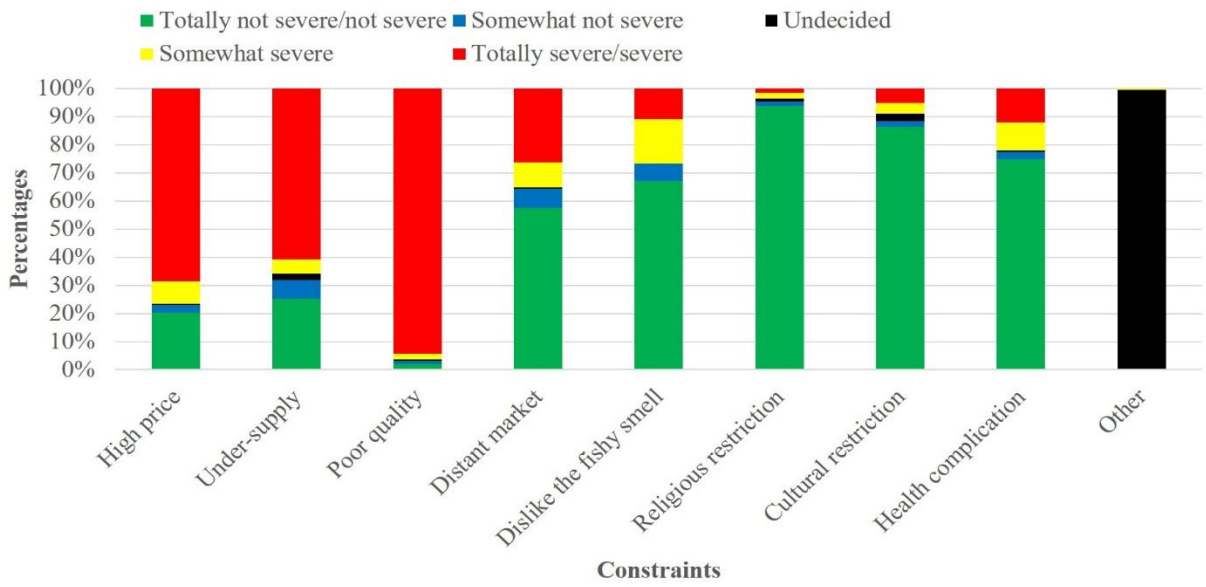


**Fig. 6. Percentages of respondents by types of constraints discouraging fish consumption (%, n=191; field data)**

Fish and fish products were accessible to households via various purchasing points or places. As shown in Figure 7.A, respondents interviewed in this study accessed fish and fish products through local market (98.9%), landing site (39.3%), mobile seller (23.1%), private customer (19.9%), supermarket (13.1%), fish farm (8.9%), self-caught fishing (2.1%), and even online (0.5%). Majority of the households were able to access fish and fish products from the local markets, also locally known as Souk.

In spite of the small percentage of respondents found actively engaged in self-caught fishing for consumption in their households (Others in figure 7.A), this revelation is an interesting avenue for further research because fish consumers in other countries rely on self-caught fishing to secure fish for their household meals. For example, a study by Von

Stackelberg et al. [67] found that more than 600,000 individuals in the United States of America (U.S.A) population were actively relying on self-caught fishing as their sole means of bringing fish for household consumption. Dependency on self-caught fishing to bring fish for household consumption might be related to those in the lowest income category as well as participation in recreational fishing, if investigated here in South Sudan as well. In developing countries where there is greater reliance on locally caught fish in the absence of fisheries management policy and/or enforcement as well as low compliance with harvest regulations [68], self-caught fishing for food should be linked to concerns over sustainability due to its probable influence on reduction in fish harvest and access to such a healthy source of animal protein. According to these authors, additionally, lack of environmental protection guidelines in developing countries to help prevent recreational and self-caught fishing in contaminated water bodies – where fish are not safe for human consumption – is also another gap that requires adequate attention; including the possibility of a complete ban on fishing in such areas, though often overlooked by some producer groups whose livelihoods are threatened.

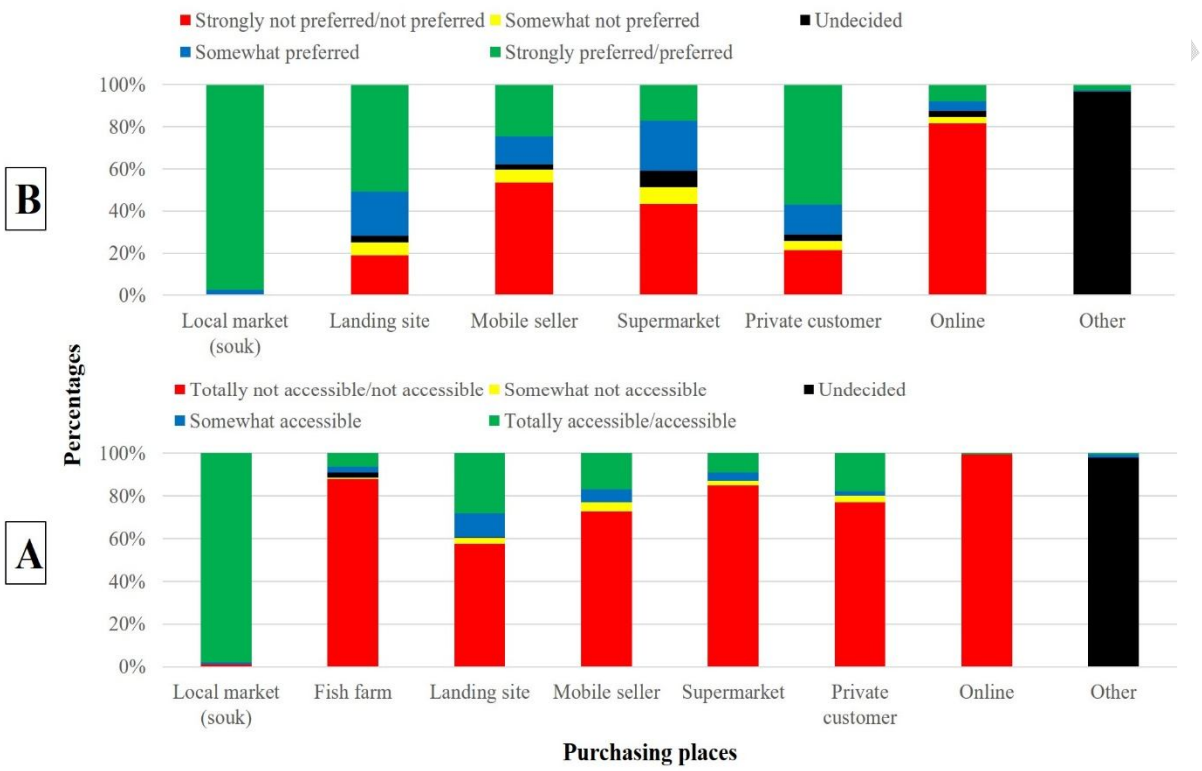


**Fig. 7. Percentages of respondents by accessibility (A) and Preference (B) to fish purchasing places**

Respondents were also queried about their preferred purchasing points to access fish and fish products for consumption in their households. In Figure 7.B, the results have shown that respondents prefer to buy fish from the local market or souk (99.5%), landing site (71.7%), private customer (71.2%), supermarket (40.9%), mobile seller (37.7%), even online (12.6%), and self-caught fishing (3.1%, other). Local market or souk, landing site and private customer were the most preferred points of purchasing fish and fish products. Since some households prefer to access fish from supermarket, mobile seller and online, these are additional opportunities for fish business, though require more details for better guidance on their utilization; online purchase in particular.

### 3.4 Information accessibility about fish and fish consumption

Access to information related to food and food consumption is often an underrated issue in developing countries. Thus, information accessibility about fish and fish consumption is considered an important variable in this survey. Selection of appropriate sources of information and communication, such as radio, television, newspaper etc. [69-71], is key in understanding options that best suited to the targeted population of interest [71]. Subsequently, a coalition could possibly be formed with these appropriate sources of information and communication to help accelerate efforts in raising awareness on the importance of healthy eating [70]. In this study, a total of 10 potential sources providing information about fish and fish consumption were selected for assessing their accessibilities (Figure 8.A) and preferences (Figure 8.B) based on the number of responses from the interviewees. Sources of information that require internet data or cost money to be accessed, such as WhatsApp (6.8%), websites (8.4%), social media (15.7%; e.g. Facebook, Twitter, LinkedIn etc.)

and newspaper (22%) among others, are generally accessible to a few respondents interviewed in this survey. These demonstrate that households' access to sources of information varies. Similar variation regarding consumers' access to sources of information was reported in Europe [72] besides trust. When such differences are acknowledged, it could help guide policymakers and nutrition educators to feasibly and effectively reach a large number of households with important awareness messages and information on food (e.g. fish etc.) nutrition extension education.

Majority of the respondents have access to information about fish and fish consumption from their family members (80.1%) and friends (64.4%). Furthermore, some respondents can access such information from social event (44%), television (43.5%) and radio (43.4%). Surprisingly, awareness training on fish and fish consumption appeared to be not accessible to many households (89%, Figure 8.A). In Figure 8.B, awareness training interestingly appeared to be the most preferred (97.9%) choice or means of accessing information about fish and fish consumption.

Moreover, Figure 8.B had shown that the most preferred sources of information were awareness trainings (97.9%) and radio (97.4%), followed by family members (96.9%), television (91.1%), friend (88.5%), social event (71.2%) and newspaper (71.7%). With that being acknowledged, awareness trainings and radio are the best media to communicate nutrition, health and other important information to the public. But the use of radio might be cheaper than relying on awareness trainings simply because of its widespread availability in different communities. Its usage already received considerable support as an effective medium of instruction for extension education [71]. Thus, radio should be considered the first choice when communicating nutrition, health and other important information to the public here in Juba and South Sudan at large. This belief corresponds with the 2021 South Sudan National Audience Survey [73]. In relation to FORCIER [73] efforts to realize opportunities for deeper audience engagement, radio was found to be the most preferred and trusted main media source used by the people of South Sudan in finding information and making decisions about health-related issues. Such a reliance on radio to find health-related topics is an encouraging avenue for spreading nutrition extension education on fish and fish consumption simply because it is accessible to many South Sudanese in different languages (including local languages). As such, fish nutrition extension education could reach all educated and uneducated listeners across different communities in South Sudan. But achieving such a milestone via radio requires well-trained facilitators and experienced educators [71].

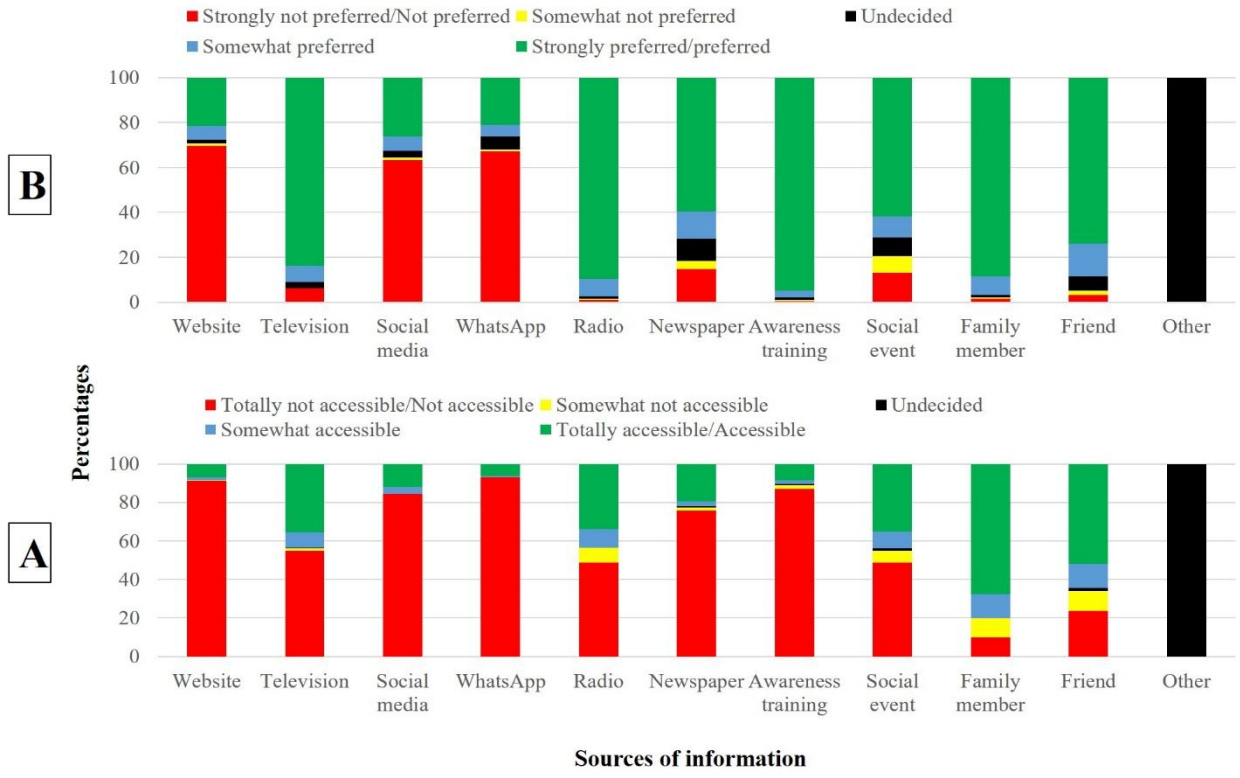


**Fig. 8. Percentages of respondents by accessibility (A) and preference (B) to selected sources providing information about fish and fish consumption**

Furthermore, it has also been noted that the least preferred sources of information were WhatsApp (26.1%), website (27.8%) and social media (32.5%). Although these three sources were found to be the least preferred, they should also be used for communicating messages or information targeting those who rely on internet-based sources of information. The

use of web-based nutrition education via World Wide Web has already been tested and recommended to help provide information on health and diseases [74], and probably fish and fish consumption as well.
The attitude of respondents toward agents of information cannot be underrated when considering access to information and the need for awareness programs about fish and fish consumption by the public. In this survey, respondents' attitudes toward eight agents of information were rated or scored to identify their perceived reliability of information (Figure 9). The results revealed variations in the perceived reliability of information across the agents.

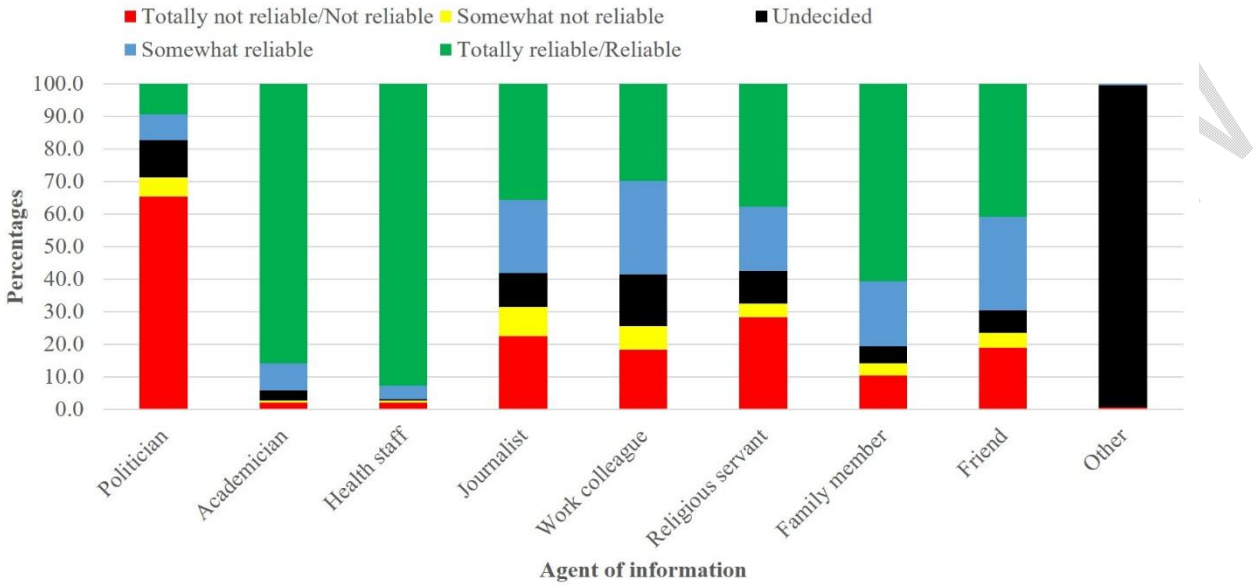


**Fig. 9. Percentages of respondents by perceived reliability of the agents of information (%, n=191; field data)**

Most of the respondents believed that the information provided by health personnel (96.9%) and academicians (94.3%) are reliable unlike their perceived reliability of information from the other agents. With more than 90 percent of the respondents confident about the reliability of awareness information from academicians in this study, it similarly reflects Hicks et al. [11] finding that the public usually rely on academicians to acquire correct and reliable information regarding the quality and safety of food products suitable for consumption. Doctors (under 'health staff' in this survey) were also known as the most trusted agent of information [69], though they often do not provide some specific nutrition-related guidance.
With the exception of politicians who were believed to be reliable only by a few respondents (17.3%), and only if the topic is related to their academic area (e.g. the Politician's undergraduate degree), the other agents of information such as family member (80.6%), friend (69.6%), work colleague (58.6%), journalist (58.1%) and religious servant (57.6%) were also considered reliable, though with some levels of hesitancy (i.e. somewhat not reliable, measured in scaled-questions) scores. Majority of the respondents questioned the worthiness of statements released by a politician with regards to fish and other nutrition-related education and awareness initiatives because they often declare unrealistic commitments and even tall tale confidently publicly. Therefore, using academicians and health staff as agents of information could help elevate consumers' confidence in buying and eating fish and fish products, and even other important messages.

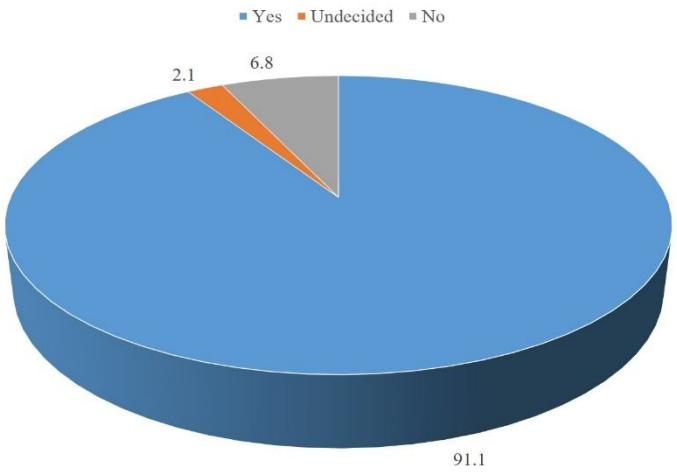


**Fig. 10. Percentages of respondents by desire for more information about fish and fish consumption (%, n=191; field data)**

Understanding the need for more public awareness initiatives is so crucial in any country with more than 50 percent of the population classified as unsecured with regards to food availability, accessibility and affordability. As a result, respondents' desire for more information about fish and fish consumption was also assessed in this study. In Figure 10, the results of the assessment had shown that there is a high demand for awareness initiatives because most of the respondents (91.1%) wanted more information about fish and fish consumption. It is an indication that there is a need for fish nutrition extension education via the accessible and preferred channels of communications and trusted agents of information found in this survey. As a complement to the need for fish nutrition extension education, engagement in fish farming [45], though requires financial and technical support, is another recommendation that could help increase the diversity and frequency of food-fish to improve the quality of nutrition in the households and probably address the recently reported lack of access to healthy food for most of the food unsecured population in South Sudan [18,19].

In exceptional cases, where mass media nutrition education initiatives on healthy eating (e.g. food-fish) via radio are limited [70], people are advised to rely on health personnel available in hospitals or health centers or schools in their communities or neighborhoods. According to Black et al. [75], nutrition education should not only underscore healthy eating but also influence policy and training on healthy rating scheme, and even best practices for optimal diet and weight gain during pregnancy among other factors that might also help change consumers' behavior. The need to develop policy frameworks that are nutrition-sensitive with a focus on wild-captured fish and farmed fish to strengthen sustainable increase in the quantity and quality of fish supply for healthy diets, as recommended by other researchers [76], should also be advocated and considered by all concerned or relevant stakeholders here in South Sudan. Sharing such information with the people of South Sudan is highly recommended. Likewise, it is so important to note that improvement in consumers' knowledge on nutrition education should be complemented by efforts to improve access to food to achieve dietary diversity [77] among households in the different communities here in Juba and South Sudan at large. Improved access to fish and fish products for dietary diversity and income in Juba and South Sudan at large could mark a major milestone in the fight against food insecurity.

## 4. CONCLUSION

In summary, this study unmasked not only consumption preference and frequency of fish and fish products among households in Juba Town, Kator and Munuki Payams of Juba County but also underscored other important variables that helped provided a better understanding of crucial issues currently influencing consumers' behavior including undersupply and unregulated prices in the local markets, accessible and preferred purchasing points, accessible and preferred sources of information, and trusted agents of information. It is probable to say men in the study areas in Juba are often less responsive to interviews that require voluntary participation. In such an urban settlement, where people have more disposable income allowing them to access fish and other animal proteins and also where fish and fish products are increasingly sold because of better infrastructures (as earlier cited), many households buy and eat fish. Moreover, majority of them (>50%) consumed fish regularly but in small amounts. So it is recommended that they should eat more fish. The households or respondents in this study even desire to buy and eat both wild and farmed fish compared to imported wild-captured fish and imported farmed fish. Besides being a cheap source of animal protein, taste and high nutritional value of fish and fish products were the dominant reasons why respondents in this survey buy and eat fish. With such motivating reasons, most of the respondents expected everyone to eat fish as well. From the list of fish species used in this study, the most preferred fish species were Tilapia, Distichodus, Perch, Clarias and Mormyrus. Dried keje

fish, though not included in the list, is another type of fish species commonly consumed by households in Juba. As such, development of science-based food recipes for dried keje fish (and Mula-Juwa as well) should be explored by researchers. Fish based and other food recipes are direly needed to combat the alarming reports of food insufficiency and food insecurity that have been observed and documented in Juba and other places in South Sudan. However, poor quality, high price and undersupply of fish and fish products were found to be the dominant constraints limiting fish consumption among households in the study areas within Juba. Respondents' concern raised over the association between allergic reactions and consumption of *Heterotis niloticus* fish should not be underrated.

In spite of the revelation that local market was the most accessible place among all the prescribed list of fish purchasing points, respondents also preferred to access fish via the other purchasing points, including landing site, private customer, supermarket, mobile seller, online and self-caught fishing. So, all the purchasing points should be considered as potential opportunities for marketing fish and fish products. Awareness trainings and radios were also found to be the best means of communicating fish and fish consumption messages, nutrition, health and other important information to the general public. When communicating such important messages or information, priority should be given to health personnel and academicians/educators to bolster consumers' trust and confidence. Respondents' desires for more information on fish and fish consumption are a call for the need to disseminate the findings of this study widely through freely accessible sources of information (e.g. radio and awareness workshops etc.) and other available media outlets. Awareness opportunities should also be utilized for dissemination of appropriate information with regards to imported fish and fish products to help combat knowledge gap and misinformation. Furthermore, those interested in fish businesses could focus on the preferred fish species and fish products and preferred sources of information revealed in this study should they want to attract and reach more consumers in Juba and even probably other communities in the whole of South Sudan. Similar studies should be conducted in other counties and states in South Sudan as well as additional research on investigating consumption of fish and fish products between seasons to reveal possible variations in preferences and frequencies from one season to another. Based on respondents' desire for more information about fish and fish consumption, it is recommended that the states and national governments should begin investing more on fish nutrition extension education, production and supply/value chain, supporting guidance in the forms of fish advisories and market access policies to help guarantee adequate availability, accessibility and affordability of fish to all households in Juba and South Sudan at large.

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