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Assessment of fresh fish value chain stakeholders' food safety knowledge and practices at the Medina Coura market in Bamako, Mali

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ABSTRACT

Fish is indeed the most important source of animal protein in the diet of the Malian population. However, in view of the multiple manipulations it undergoes from its capture to its sale, it is subject to multiple cross-contaminations which constitute threats to its safety. The study aimed to assessing the level of food safety knowledge and practices among the fish sellers in Medina Coura market at Bamako with the fishermen in four fishing areas (Selingue, Manantali, Markala and Mopti) located along the Niger and Senegal rivers in Mali. A structured face-to-face questionnaire was designed and administered to 247 respondents (117 fishermen and 130 selllers) were interviewed in the value chain between November 2018 and February 2019. Data on demographics, business characteristics, knowledge and practices in food safety was collected by purposive sampling methods, descriptive analyses were done with frequencies and summary statistics. Chi-square statistics were computed to determine significant relationships and the p-value was set at 0.05 significant level. The majority of sellers were female (84.6%) and fishermen were male (100%) with the majority of both being above 40 years of age. Fishermen and sellers at Bambara had primary education (63.3% respective) while fishermen at Bozo had no formal education (78.6%). Spearman's correlation coefficient revealed that knowledge has significantly influenced the fish safety practices of the fishermen ($P < 0.05$). However, age and duration of service had no effects on the fish safety knowledge of the fishermen ($P > 0.05$). Fish safety knowledge of the vendors has a significant positive impact on their safety practices. Respondents having received no formal education in food safety. It was more exposed to bad practices at the level of sellers than fishermen. In view of the above, it is, important to put in place a good public health management strategy for food sales services which will give them the knowledge and skills necessary to provide hygienic and safe sales services.

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Keywords: Fish safety knowledge, food safety practices, fishing sector, Medina Coura market.

INTRODUCTION

Once fish has been caught, the stakeholders in the fishing line handle the fresh fish directly at different stages of the catching chain, landing, and finally at the point of sale. This manipulation concerns, among other things, removing the fish from the fishing nets, sorting, classification washing, and storage under ice (Sissoko, 2022). After harvest, the losses of fish are in principle applied by its microbiological biochemical alteration, which occurs after death. Live fish has natural defense mechanisms that could prevent spoilage. However, when the fish dies, its defense system stops and the microbiological enzymatic and oxidative deterioration begins, the quality of the fish deteriorates (Diei-Ouadi and Mgawe, 2011). The factors intervening in the rapid deterioration of the fish are among others the time, temperature, and handling. Food safety is a real public health problem in the world more precisely in Africa because foodborne illnesses are very common. Microbial agents including various pathogenic bacteria, parasites viruses, and chemical contaminants are becoming increasingly important. Microorganisms present in foodstuffs can cause organoleptic changes and alter the marketability of products, or constitute a danger to public health due to their pathogenic power for humans (Bornert, 2000; Sivapalasingam et al., 2004; Suthar et al., 2008).

The main predisposing factors are human factors such as unhygienic practices and cross-contamination and environmental factors, such as waste disposal and exposure of food to dust and insects, unsafe water, undercooked food, and long-term storage of food cooked without refrigeration (Mensah et al., 2012). However, consumers are increasingly concerned with the safety and quality of food and demand more transparency in food production and distribution. Food safety and hygiene practices are very important at all levels of the value chain because they help prevent infection and food poisoning. Food can be infected at all levels in the chain: Processing food can affect its quality and this depending on the temperature, the application,

and the pH of the atmosphere in which it is processed, this food can potentially be dangerous for the health of the consumer (Akonor, 2013).

Unsafe foods pose global health threats, endangering everyone children, pregnant women, the elderly are the most vulnerable. Each year, 220 million children contract diarrheal diseases and 96,000 dies from them (WHO, 2015). The major concern for all governments is the trade-in of contaminated food between countries which increases the potential for epidemics and therefore a health risk due to microbial pathogens in food (Velusamy et al., 2009). Respecting food safety and hygiene along the value chain is an important practice to guarantee the safety of our food. This will prevent the rapid infection of harmful germs in our food during the manufacturing process and thus make the food fit for consumption (Mgqibandaba et al., 2020).

This research therefore aimed at assessing knowledge and practices in terms of food security along the value chain of the fishing sector in Medina Coura market and to generate reference data to contribute to the improvement of this sector based on evidence that will enable industry players to develop, implement and maintain effective food security for systems management.

MATERIALS AND METHODS

Selection of samples

In all, 247 respondents participated in this study. 130 respondents worked in the market of Medina Coura as fish sellers and 117 were in the fishing point (31 respondents in Selingue, 25 in Manantali, 31 in Markala, and 30 in Mopti) as fishermen in the various areas of sampling.

Questionnaire development and administration

These stakeholders were interviewed based on a purposive sampling technique for their food safety knowledge and practices. Respondents were contacted directly at their place of work where the purpose of the study was explained to them and their informed consent was sought for and obtained. The

choice of a structured questionnaire was made and used as a data collection instrument. The questions were interpreted in the national language “Bambara” for all the answers and their answers were recorded in the questionnaire. The average completion time for each questionnaire was 15 minutes.

Purposive sampling methods were adopted to recruit available respondents. The declarations on the questionnaire were obtained from previous studies (Kunadu et al., 2016; Aboagye et al., 2020) and modified to correspond to the objective of the present study. These questions had been selected to elicit responses that can serve as a basis for assessing awareness and understanding of fish safety and handling techniques. The questionnaire included 58 questions consisting of 29 questions for market fish sellers and 24 questions for fishermen at the fishing point in the four sampling areas. The 130 fish sellers of the study were chosen according to the recommendations of the president of the fishermen's cooperative, fish farmers, a freshwater fish vendor in Medina Coura market. This choice concerned sellers specializing in the marketing of freshwater fish on the market.

The questions varied according to the types of stakeholders. For the vendors of the Medina Coura market, they were divided into four sections.

Demographic characteristics are age, sex, ethnic group, level of education; type of sellers; techniques and method of carrying out the activities; knowledge of food safety; and food safety practices. The questionnaire designed for fishermen at the fishing points was divided into four sections also; Demographic characteristics (age, sex, ethnic group, level of education; the level of experience in fishing activities); Business characteristics; Knowledge about food safety and food safety practices.

In the Knowledge and Practice sections of the questionnaire, open and more detailed responses were used. For each answer, the score of the questions was summarized and converted into percentages (0 to 100).

Data processing and analysis

The data gathered from the survey was analyzed using Microsoft Excel and Statistical Package for the Social Sciences (SPSS) version 21.0. The frequencies and percentages of responses to the questions were calculated and contributed using the frequency distribution tables. The effects of food safety knowledge on safety and hygiene practices were determined by Spearman's rho correlation coefficient.

RESULTS

Demographics of respondents

In all 247 respondents participated in this study. 130 respondents worked in the market of Medina Coura as fish sellers and 117 worked as fishermen in fishing point in various areas of sampling (Table 1). Among the respondents in the market, the sale of fresh fish was dominated by women (84.6%), but this was not a case fishing area where the fishermen were all men. The majority of respondents are over 40 years of age. Also, the majority of fishermen (78.6%) had no formal education, and sellers had an incomplete basic school education (53.1% middle school and 40.0% primary school). The majority of the sellers were Bambara (48.5%) and the fishermen were Bozo (64.1%). For the fishermen, the level of experience in fishing activities ranged from 0-40 years with a majority (85.5%) having between 31-40 years.

Business characteristics

Table 2 shows how business takes place in the fresh fish sales process. In Medina Coura market, fish comes from different areas; 8.5% are sourced from Mopti and Markala, 52.3% from Mopti-Segou-Manantali, 25.4% Mopti-Selingue-Gao-Manantali, and 13.8% from Mopti-Selingue. The means of transport is by public transport (car) 99.2%. The time taken to sell fish on the market is between 2-3 days (80%). 100% of sellers believe that the quantity of spoiled fish is low.

Fishermen

The fishing gears used by respondents were variable depending on the areas (Table 3). In some areas, either the number of canoe

owners was low or some fishermen did not have the financial means to have motorized canoes. According to the respondents, there was no difficulty in selling freshly caught fish, once they come on shores, the women bought all the fish from them as wholesalers to sell them locally or send them to Bamako for sale. In this study, fishermen faced a lot of difficulties resulting in a huge loss in their activities which among are others included the mining in the area of Selingue, lack of fish in water, theft of fishing gear, and also insecurity in the North even part of the country.

Food Safety Knowledge

From this study, it is shown that the respondents had a good knowledge in food safety but could not translate it into food safety practices (Table 4). A total of 100% of fishermen were aware of fish spoilage fish and they thought that the way the fish were handled could contribute to their spoilage.

Food Safety practices

Fish sellers

All fish sellers received the fish from different areas in baskets containing ice. In Medina Coura market we observed unsanitary conditions of the sales outlets, fish was stored in broken-down fridge with ice, and for selling, it was put on mat laid on the ground some time without ice. The breaking of the cold chain following the use of broken down freezers with their walls covered with rust, in which worn bags are placed to prevent their contact with the products and also prevent the escape of cold produced by ice are improper techniques.

About 93.8 % of fish sellers displayed their products on the floor mat.

Fishermen

After capture in all the areas, the majority of the respondents lost their fish, Selingue (100%), Manantali (100%), Markala (87.1%), Mopti (66.7%) (Table 5). During transport, the delay was often due to vehicle breakdown or stopping of the vehicle by customs or lack of potable roads linking the landing point to the markets, where, the fish is washed in contaminated water.

The relationship between age, duration of service, and fish safety knowledge and practice of the fishermen

The bivariate Spearman’s rho correlation coefficient was used to investigate whether or not knowledge had any influence on fishermen’s fish safety practice, and also to find out if age and duration of service had any influence on their knowledge. The results reveal that knowledge significantly influenced the fish safety practices of the fishermen (P < 0.05). However, age and duration of service had no effects on the fish safety knowledge of the fishermen (P > 0.05).

The relationship between age, education, and fish safety knowledge and practice of the sellers

The results of the relationship between age, duration of service, fish safety practice, and knowledge revealed that the fish safety knowledge of the vendors had a significant positive impact on their safety practices (P < 0.05).

Table 1: Demographic characteristics of the study population.

Variable	% Stakeholder (n)		
	Sellers (n=130)	Fishermen (n=117)	
Gender	Male	15.4 (20)	100(117)
	Female	84.6 (110)	0
Age	18-24 yrs	0	9.4(11)
	25-29yrs	1.5(2)	5.1(6)
	30-39yrs	20(26)	24.8(29)
	> 40yrs	78.5(102)	60.7(71)
Ethnic Group	Bozo	29.2(38)	64.1(75)

	Bambara	48.5(63)	18.8(22)
	Malinke	6.2(8)	10.3(12)
	Songhai	2.3(3)	0.9(1)
	Soninke	3.1(4)	2.6(3)
	Fulani	10.8(14)	3.4(4)
Educational Level	Middle School	53.1(69)	0
	Secondary	3.1(4)	0.9(1)
	Primary	40(52)	20.5(24)
	No formal education	3.8(5)	78.6(92)
Stakeholders	Wholesaler	65.4(85)	100(117)
	Wholesale-Retailer	33.8(44)	0
	Retailer	0.8(1)	0
Number of years	1 – 10	5.4(7)	4.3(5)
In fishing activity	11-20	24.6(32)	10.3(12)
	21-30	25.4(33)	0
	31-40	44.6(58)	85.5(100)

n: frequency

Table 2: Frequency of fishing businesses by the fish sellers.

Variable	Categories	% Sellers (n=130)
Origin	Mopti-Markala	8.5 (11)
	Mopti-Segou-Manantali	52.3 (68)
	Mopti-Selingue-Gao-Manantali	25.4 (33)
	Mopti-Selingue	13.8(18) (5)
Means of transport	Car (public transport)	99.2 (130)
Refrigerated truck		0.8(1)
Flow time	2-3 days	46.9 (61)
	7 days	0.8(1)
	1 day	46.2(60)
	3-4 days	4.6(6)
With what measure do you sell your fish in the market?	In weight (Kg)	100(30)
	Per basket	0 (0%)
How many kilo can contain one basket?	300kg	65.4(85)
	600kg	34.6(45)
How many baskets do you take from various areas?	4-6 Baskets	64.6(84)
	1-3 Baskets	33.1(43)
	1-7 tonnes	0.8(1)
	1 tonne	1.5(2)
What is the frequency of reception of fish per week?	2 -3 days	1.5(2)
	4-5 days	15.4(20)
	6-7 days	83.1(108)

How much time does the fish spend before it gets the market		
	>24hrs	33.1(43)
	11-15 hrs	63.8(83)
	6-10hrs	3.1(4)
Can you estimate the average amount of spoiled fish per batch?		
	1-5 fish	53.8(70)
	6-10 fish	14.6(19)
	11-20 fish	31.5(41)
Have you encountered sick fish in the lot you selling?		
	Yes	100(130)
How do you display the fish for sale?		
	On floor mat	93.8(122)
	On table	6.2(8)
How do you store fish during the sales period?		
	In a broken fridge with ice	100(130)

n: frequency

Table 3: Business activities of fishermen in selected fishing areas.

Variables	Categories	%Areas (N=117)		
		Selingue (31)	Manantali (25)	Markala
(31) Mopti (30)				
What fishing gear do you use for fishing?				
	Gill net	80.6(25)	40(10)	100(31)
	60(18)			
	Cast net	6.5(2)	-	-
	7(11)			
	Fishing net	12.9(4)	4(1)	-
	-			
	Seine net	-	56(14)	-
	3.3(1)			
What types of fishing canoes do you use?				
	%Canoes no-motorized	-	-	100(31)
	16.7(5)			
	%Canoes motorized	100(31)	100(25)	
	83.3(25)			
How do you do your fishing activities?				
	The nets are left at 4 p.m. and collected overnight	100(31)	28(7)	96.8(30)
		73.3(22)		
	Spend 4 to 5 days in the lake	-	8(2)	-
	-			
	Spend 5 to 7 days in the lake	-	64(16)	-
	-			
	Spend less than 2 hours in the river	-	-	3.2(1)
	26.6(8)			
Which period of the year is fishing most beneficial to you?				

February - September	100(31)	-	-
-			
June - August	-	100(25)	-
-			
November - January	-	-	100(31)
100(30)			
What is the average quantity of fish you harvest by shipment?			
1-20Kg	96.8(30)	16(4)	74.2(23)
40(12)			
21-40Kg	3.2(1)	8(2)	16.1(5)
13.3(4)			
41-60Kg	-	16(4)	3.2(1)
26.7(8)			
61-80Kg	-	8(2)	-
3.3(1)			
>100Kg	-	52(13)	6.5(2)
16.7(5)			
How often do you go fishing?			
4-5 Days/week	3.2(1)	16(4)	-
6.7(2)			
6-7 Days/week	96.8(30)	81(21)	100(31)
93.3(28)			
In average, how much time do you spent on each shipment?			
> 2hrs	-	-	-
46.7(14)			
2-6hrs	96.8(30)	100(25)	96.8(30)
36.7(11)			
7-12hrs	3.2(1)	-	3.2(1)
16.7(5)			
What are the problems you are having?			
The use of pesticides in water by miners (cyanide, Mercury)	87.1(27)	-	-
-			
Lack of fish in a water	3.2(1)	44(11)	51.6(16)
30(9)			
Lack of ice and storage material	9.7(3)	56(14)	9.7(3)
40(12)			
Theft of fishing gear	-	-	9.7(3)
3.3(1)			
Insecurity in a North of the country -	-	-	9.7(3)
26.7(8)			

n: Frequency

Table 4: Responses to questions on food safety knowledge by fish sellers.

Variable	Categories	%Fish	
sellers (n)			
Do you know spoilt fish?	Yes	100(130)	
Do you know what causes fish spoilage?	Lack of ice	64.6(84)	
	Broken down car	34.6(45)	
	Insanitary condition of sale	0.8(1)	
	Yes	100(130)	
Do you think the way the fish is handled contributes to its spoilage?	Yes	100(130)	
Have you encountered sick fish in the lot you are selling?	Yes	100(130)	
	If yes, please describe the state of the spoiled fish	Texture change	47(61)
		Change in eye color	15.4(20)
		Discoloration	10(13)
Do you think the infected fish could cause illness?	Fish swelling	27.2(36)	
	No	74.6(97)	
	Yes	25.4(33)	
If yes, which kind of disease?	Abdominal pain	15.4(20)	
	Diarrhea	84.6(110)	
With your experience, point out some of the observations that can alert a buyer that a fish is infected, sick, or unhealthy			
	Yes, the buyer is always informed that the fish is spoiled	100(130)	
What measures could be taken to ensure that the fish in our local markets are healthy and safe for human consumption?			
	Need a refrigerated truck for transport, and a cold room	83.1(108)	
	Financial aid	0.8(1)	
	The vehicle stopped by customs for a long time	9.2(12)	
	Unsanitary conditions, lack of evacuation system	6.9(9)	

n: frequency

Table 5: Responses to questions on food safety knowledge by fishermen.

Variable	Categories	%Areas (n=117)		
		Selingue	Manantali	Markala
Mopti				
Do you know the spoiling fish? 100(30)	Yes	100(31)	100(25)	100(31)
	No	-	-	-
-				
Do you think the way the fish are handled could contribute to their spoilage?	Yes	100(31)	100(25)	100(31)
	20(6)			
	No	-	-	-
80(24)				

n: frequency

DISCUSSION

Demographics of Respondents

The activities of selling fish were exclusively reserved for men, while women were involved at several levels from capture to sale. Similar studies have also reported a higher proportion of women than men in food vending (FAO, 2013; Kunadu et al., 2016, Iwu et al., 2017, Aboagye et al., 2020, Mqgibandaba et al., 2020). According to FAO, (2013), women were dominant in the secondary sector, which is handling, storage, and processing of fishery products, especially in collection activities, they were generally considered to be appropriate activities for women given their home and tasks and responsibilities related to family care. The predominance of women in the sales sector could be attributed to their traditional responsibilities of housework and childcare, they contribute to balancing the income-generating opportunities playing a key role in poverty mitigation and food security (Omemu and Aderoju, 2008; FAO, 2013). In Mali, fishing is a family activity and according to agents of local authorities, almost 90% of all fishing activities in the country are managed by women. In fishing communities, women are considered the heads of households. The men give their harvest of fish to the women, who decide what to do with it (Peterson and Kalende, 2006).

In the present study, the majority of respondents were over 40 years of age this could be explained by the fact that the choice of speakers was made according to the criteria of duration and stability in the field. These were also similar to the results of Mqgibandaba et al. (2020) whose survey revealed that 40% of their respondents were between 31 and 40 years old and that of Kunadu et al. (2016) of which 31% were between 36-50 years old and in the lagoon communities in Nigeria fishermen this age group represented was 42.5 % of fishermen (Fregene, 2002).

The lack of formal education was in agreement with other studies carried out by Zanin et al. (2015) where 51.8% had an incomplete basic school education and that of Aboagye et al.(2020) where 32% of fishermen had no formal education. This could be also an impact on the safe delivery of fish and result in

a positive change in food handling behavior. In Bamako, Bambara is the main ethnic group and fishing belongs to the Bozo or the sedentary professional fishermen for whom fishing represents a full-time economic activity. For the seller study population, 65.4% were wholesalers while 33.8% were retailer. In Mali, the marketing circuit for fresh fish shows that the wholesaler at the same time serves as the retailer or the consumer from which he is most favored. The retailer is the least favored hence its more expensive fish (Traore, 2014). According to FAO, (2013), family communities that practically monopolize the fishery sector operate in the sector.

Business characteristics

Data obtained by FAO, (2007) asserts that the major capture sites are in order of importance, the Central Delta of Niger at Mopti (80,000 to 90,000 tons), Lake Selingue (4,000 tons of fresh fish), and Lake Manantali (3,000 tons of fresh fish). The process of transporting fish to Bamako has trouble linked among other things to socio-political crises, restrictive administrative and customs procedures and especially the instability in the northern part of the country, causing the majority of fishermen to abandoned their activities. Poor transport could lead to an increase in the shelf life of the fish, which favors the degradation of the fish leading to a drop in the price of the product (Diei-Ouadi and Mgawe, 2011). Post-harvest loss in fishing activities is a major concern since it is equivalent to the loss of animal protein for consumers and a loss of income for fishermen, processors, and traders (Diei-Ouadi and Mgawe, 2011).

Fishermen

Malian fishermen use a wide range of gear and catching techniques, adapted to the conditions, to the environment, and also depending on the season (FAO, 2007). Exposure to fishing gear for long periods could lead to spoilage of the fish, especially at high temperatures. In a James Town study in Ghana by Ocloo (2015), reported that fishermen are forced to sell their catch immediately after a catch at low prices to wholesalers or the retailer since they have no means of stocking fish. In

his study fishermen complained about the reduction in a fish caught over the years. In the last two decades, PADEPECHE (2004) reported that because of the drought, the incomes of fishermen have been reduced, demographics factors (increase in the population of fishermen) have contributed to reduced economic returns as well as technical and economic factors (diversification of fishing gear and multiplication of fishing effort) and commercial factors (poor valuation of products, reduction in the quantity of marketable fish).

Food safety knowledge

A similar study done by Grema et al. (2019) indicated that the importance of food safety knowledge of food handlers was necessary as good knowledge mostly translates into positive behavior and practices leading to safe food production and handling. All personnel involved in handling processes must maintain good hygiene, a high degree of cleanliness to ensure food safety in food preparation and also to avoid contamination of the diet with pathogenic microorganisms. This study was not consistent with the study by Iwu et al. (2017) in Nigeria where knowledge, attitude, and training were significantly associated with the practice. Similarly, a study in Nigeria by Otu (2014), declared that knowledge was not linked to practice and that this was attributed to the existing socio-cultural context that probably had a greater influence on safe eating practices. The study revealed that the level of knowledge could not be significantly associated with the food hygiene practices of the responses.

Food safety practices

Fish sellers

According to the FAO and WHO (2012), fish sale areas must be in good condition, durable, and easy to maintain and disinfect. Appropriate and adequate facilities must be provided for the storage and/or production of ice.

Fishermen

The loss of fresh fish could be due to the inadequate use of ice from capture to sale, the

use of freezers without insulation in the market rate of and the exposure of fish on the ground at room temperature were often high. According to FAO and WHO (2012), fish cleaning water must be potable to avoid cross-contamination.

The relationship between age, duration of service, and fish safety knowledge and practice of the fishermen

The more fish safety training and workshops organized for the fishermen for more knowledge, the more it will enhance their fish safety practices. Besides, the sufficient safety knowledge of the fishermen does not matter how long they stay in business or how old they are.

The relationship between age, education, and fish safety knowledge and practice of the sellers

This result implies that the more educated the vendors are the more knowledge they have and the more their fish handling behavior will be positively influenced. This means regular training and workshops will greatly improve their fish safety knowledge and practice.

Additionally, the age and educational status of the vendors also have a positive influence on their knowledge. Implying the older they are and the more educated they are, the better their relationship with fish along the value chain. The results differ from the findings of Grema et al. (2019) in Kaduna State, Nigeria, which indicated that most fish sellers had good knowledge of food hygiene practices such as handwashing. However, knowledge about hygienic handling of fish could not be translated into practice. Besides the food safety knowledge of the fishermen is not influenced by the length of service in the fishing business nor their age. This finding is similar to the findings of Grema et al. (2019) who found a positive correlation recorded between knowledge and practices ($r_s = 0.2$, $P = 0.23$) but a negative correlation (n) between practices with years of business experience ($r_s = -0.03$, $P = 0.830$).

Conclusion

This study showed that despite good knowledge and practices of fishing stakeholders, their food hygiene practices are insufficient. Fish handlers have taken no formal food safety training. So, there is a need to train these actors for behavioral changes to occur. Given the importance of fish in diet in particular, there is a need to strengthen vigilance and control of fishing activities in particular in good conservation, by applying good hygienic practices applied and controlling Food Safety. In the interest of public health, waste should be assessed by the authorities to avoid and control the potential risk and spread disease through these foods. Fishermen and sellers must have training in good hygiene practices, initial medical certification and periodic medical examinations, and regular checks of personal hygiene and in particular of the environment.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

AS designed the topic, collected data, conducted the laboratory analysis and wrote the manuscript, while FS, TDK, APHK and ST approved the topic, supervised and reviewed the manuscript. FKM and BMdAM conducted the data analysis, and formatted the manuscript.

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