

Czech University of Life Sciences Prague
Faculty of Tropical AgriSciences
Department of Economics and Development



Bachelor thesis

**Potential impact of socioeconomic development
on current use of fish and culinary herbs
in Cambodian traditional cuisine**

Supervisor:

Ing. Vladimír Verner Ph.D.

Author:

Helena Kissová

Prague-Suchdol, 2018

BACHELOR THESIS ASSIGNMENT

Helena Kissová

Agriculture in Tropics and Subtropics

Thesis title

Potential impact of socioeconomic development on current use of fish and culinary herbs in Cambodian traditional cuisine

Objectives of thesis

The objective of the thesis is to contribute to understanding whether, and if yes, how recent economic and social dynamics influence Cambodian culinary tradition of fish species. Thus, the particular aims of the thesis will be to document what fish species are commonly used for consumption by households in Cambodia, and from which places there are obtained (markets, fishing), what is the origin with respect to natural resources or aquaculture, what are the most common herb species used for fish preparation and what is the origin of these species.

Methodology

Data will be collected during summer months in two chosen areas in Cambodia, with special focus on urban areas where current socioeconomic changes are more alarming. Market places will be used as a place for approaching the respondents, interviews and data sheets will serve as the main data collection technique. Data will be further analysed via standard statistical methods.

The proposed extent of the thesis

20-25 pages; 9,000 words incl. text, tables, figures and references

Keywords

aquaculture; fish processing; interviews; homegardens; local markets; Siem Reap; Phom Penh; Cambodia

Recommended information sources

FAO yearbook of fishery statistics. : Vol. 89. ROME: FAO, 2001. ISBN 92-5-004586-7.

Rangers, 2011

ROBERTS, M. *Book of herbs : the medicinal and culinary uses of herbs in South Afrika.* PRETORIA: JONATHAN BALL PUBLISHERS, 1983.

SINGH, B K. – EBRARY (FIRMA). *Applied fisheries and aquaculture [elektronický zdroj].* Delhi: Swastik Publishers & Distributors, 2008. ISBN 9788189981167.

VAN, W Y. *The practical book of herbs. : growing and using herbs in South Africa.* CAPE TOWN: CHAMELEON PRESS, 1986.

Expected date of thesis defence

SS 2017/2018 – FTA

The Bachelor Thesis Supervisor

Ing. Vladimír Verner, Ph.D.

Supervising department

Department of Economics and Development

Electronic approval: 9. 4. 2018

Ing. Vladimír Verner, Ph.D.

Head of department

Electronic approval: 16. 4. 2018

doc. Ing. Jan Banout, Ph.D.

Dean

Prague on 20. 04. 2018

Declaration

I hereby declare that the present bachelor thesis called „Potential impact of socioeconomic development on current use of fish and culinary herbs in Cambodian traditional cuisine“ is my own work and all the sources have been quoted and acknowledged by means of complete references.

In Prague, 20 April 2018

.....

Helena Kissová

Acknowledgement

I would like to sincerely thank to my supervisor, Ing. Vladimír Verner, Ph.D., of the Department of Economics and Development, Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, for his time and patience. His consultations were extremely beneficial to my work on this thesis. I would also like to acknowledge the willingness of all the vendors and other respondents who participated in my data collection. Last, but not least, I want to thank to my parents, colleagues and friends for their support.

Abstract

Fish are one of the most important sources of protein for the world population particularly in developing countries. However, current decline in their natural ecosystem, has resulted in the proliferation of fish farmings. One of the countries where fish is an integral part of the local diet is Cambodia. This country, has been enjoying significant economic growth for the last two decades but also faces a number of problems related to the development of agriculture, construction, tourism, nutrition, rural migration to cities, water and air pollution etc. A major issue in Cambodia and other similar countries, is how these trends can affect the attitude of their population to fish. That is why this study has three objectives, the first is to document which fish species are most commonly consumed by the local population. The study also documented which factors affect buying of these fish, whether it is taste, cleanlinesses, price, tradition or anything else. In addition, the study looked at where the fish came from, whether they are from freshwater, saltwater or from fish farms. The second objective of the research was to identify the plant species and herbs used for the culinary preparation of fish dishes by local households, as well as to ascertain where spices are obtained markets, gardens, forests etc. The third is to describe the relevant social aspects as traditions, habits, household etc. And economic aspects as availability, price, market etc. Study documented twenty-one fish species regularly consumed by the respondents, very often the origin was giant snakehead. Furthermore, twenty-five culinary herbs were used in combination with fish to prepare different meals, majority of them (55%) were purchased at local markets. Study thus documented that despite of decrease of natural stocks, local population still prefers fish from natural ecosystems. This might change in the future as majority of herbs, previously grown in local gardens, are now commonly purchased at markets. Study suggests to carry out a survey on consumer attitudes towards fish from aquacultural production to better understand the whole complexity of the system.

Key words: aquaculture, fish processing, homegardens, interviews, local markets, Phnom Penh, Siem Reap

Abstrakt

Ryby představují jeden z nejdůležitějších zdrojů bílkovin pro světovou populaci, zejména pro rozvíjející se rozvojové země. Současný pokles jejich stavu v přirozeném ekosystému vede k rozšiřování jejich chovů na farmách. Jednou ze zemí, kde ryby tvoří nedílnou součást jídelníčku je i Kambodža. Země, která dosahuje v posledních dvou dekadách vysokého ekonomického růstu, ale také se potýká s řadou problémů spojených s rozvojem zemědělství, stavebnictví, cestovního ruchu, výživou, migrací z venkova do měst, znečištěním vod a ovzduší atd. Otázkou u Kambodži i ostatních zemí zůstává, jak mohou tyto trendy ovlivnit postoj populace ke konzumaci ryb. Proto měla studie za úkol tři cíle, z nichž první z nich byl zdokumentovat druhy ryb, které jsou nejvíce využívány ke konzumaci místními obyvateli ve sledovaných oblastech. Studie také dokumentovala, který faktor nejvíce ovlivňuje místní při koupi ryby, zda je to chuť, čistota, cena, tradice či něco jiného. Dále se studie zabývala tím, odkud ryby pocházejí, zdali jsou ze sladkovodních, mořských zdrojů či rybích farem. Druhým cílem výzkumu bylo identifikovat rostlinné druhy používané pro kulinářskou přípravu rybích pokrmů místními domácnostmi, také zjistit odkud koření získali – trhy, zahrady, lesy. Za třetí zdokumentovat a popsat relativní sociální aspekty jako tradice, návyky, domácnost atd. A ekonomické aspekty jako dostupnost, cena, trh atd. Studie zdokumentovala dvacet jedna druhů ryb, které respondenti pravidelně konzumovaly. Dále, dvacet pět druhů kulinářských bylin, bylo zdokumentováno a použito v kombinaci s rybami k přípravě různých jídel, většina z nich (55%) byla zakoupena na místních trzích. Studie tak zdokumentovala, že navzdory poklesu přírodních populací místní populace stále preferuje ryby z přírodních ekosystémů. To by se mohlo v budoucnu změnit, jelikož většina bylin, které se dříve vyráběly v místních zahradách, jsou nyní běžně zakoupeny na trzích. Studie navrhuje provést průzkum, týkající se postojů spotřebitelů vůči rybám pocházejícím z akvakulturní produkce, aby lépe porozuměl celé složitosti systému.

Klíčová slova: akvakultura, domácí zahrady, zpracování ryb, místní trhy, Phnom Penh, rozhovory, Siem Reap

List of tables

Table 1 Population growth from 2000-2017	13
Table 2 Population growth in Phnom Penh.....	13
Table 3 An overview of the fish species mentioned in the questionnaire.....	17
Table 4 An overview of herbs, spices and vegetables from questionnaire	20
Table 5 Socio-economic profile of households.....	21

List of figures

Fig. 1 Worldwide annual fish consumption per capita	2
Fig. 2 Global fish production from aquaculture and wild capture, 2014.....	4
Fig. 3 Fishermen preparing to fish in Phnom Penh	5
Fig. 4 Fish for sale, Central Market in Phnom Penh	8
Fig. 5 Herbs, spices and vegetables for sale, Old market in Siem Reap	9
Fig. 6 The climate of Siem Reap vs. Phnom Penh	11
Fig. 7 Map of the world with detail of Cambodia	12
Fig. 8 The most commonly consumed fish in Siem Reap and Phnom Penh.....	16
Fig. 9 Why the sourcing of fish is important for respondents	18
Fig. 10 Sources of fish	18
Fig. 11 Dried fish at the Central Market.....	19
Fig. 12 Fresh fish on ice	19
Fig. 13 The most common herbs in Siem Reap and Phnom Penh.....	21
Fig. 14 The most common occupation of respondents' household members.....	22
Fig. 15 Spicy redfish soup	23
Fig. 16 Barracuda as a main dish.....	23
Fig. 17 Giant snakehead ready at the market for sale.....	24
Fig. 18 Lemongrass in a bunch.....	25
Fig. 19 Wide range of spices and vegetables.....	27

Content

Declaration	i
Acknowledgement	ii
Abstract	iii
Abstrakt	iv
List of tables	v
List of figures	vi
Content	1
1. Introduction	2
2. Literature review	5
2.1 The history of fishing and aquaculture.....	5
2.2 A global overview of fishing and aquaculture	6
2.3 How fisheries and aquaculture affect the economy in Cambodia.....	6
2.4 Consumer preferences and fish	7
2.5 Local agricultural markets in Cambodia	8
2.6 The cultivation and production of spices	9
3. Aims	10
4. Methodology	11
4.1 Study sites description.....	11
4.2 Data collection and analysis	14
5. Results	16
5.1 Fish species consumed by respondents	16
5.2 The most common herbs and spices used as seasoning by respondents	19
5.3 A breakdown of local households	21
6. Discussion	23
7. Conclusion	28
References	29

1. Introduction

Fish represent an essential part of the diet, cultural traditions and employment opportunities all over the world. This is especially true of typical countries with rich water resources or access to open the sea. A country with one of the highest percentages of annual fish consumption per capita is Cambodia, in southern Asia. It has been documented that fish accounts for about 75% of animal protein in the average diet of the local population, most of which comes from freshwater fishing (FAO 2011). Furthermore, fish are also a unique source of energy, vitamins and especially essential fatty acids, that affect human health and prevent disease (Silva et al. 2012).

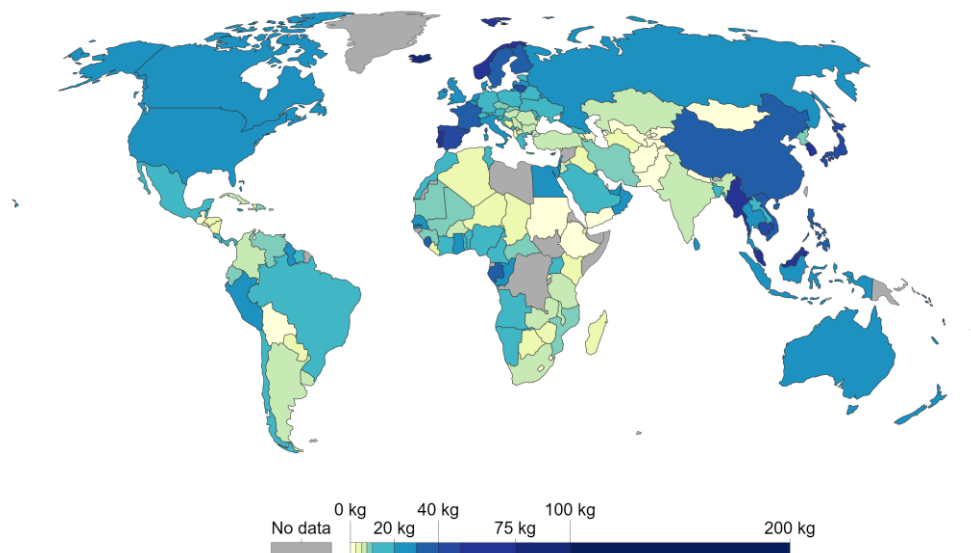


Fig. 1 Worldwide annual fish consumption per capita

Source: Our world in data, 2013

The tradition of consuming fish, is rooted in Cambodia’s ancient history, and recipes for fish preparation have been preserved for generations. Thus, fish also have cultural significance, as is evidenced by their celebration in songs and depiction, in art from paintings to textiles. Also, the fact that the Kingdom of Cambodia is a coastal country affects fish consumption: the long coastline of the country provides access to plenty of saltwater fish, and the country’s many lakes and rivers are a “seemingly endless” source of freshwater food (Rangers 2011).

Since the dawn of mankind, fish has become a staple food for the majority of people groups dwelling in close proximity to water sources, which is certainly the case for Cambodia, where the population is concentrated along the fertile banks of the Mekong River and Tonle Sap Lake (LAO PDR 1998). Cambodian water areas cover around 1.6 million hectares, which explains the fact that fisheries have become such an important part of the national economy, according to statistical calculations, around 420,000 Cambodian residents are employed in the fisheries sector (FiA 2009).

Since fishing is largely unregulated, it is often exploited, which has resulted in dwindling fish populations, and for some countries, a significant impact on their inhabitants. Overfishing has led to losses; for example, some methods of fishing, such as hunting method using dynamite or cyanide, can be devastating to the functioning of the ecosystem. As fishermen still fish regardless of the friction period, fish populations are unable to recover quickly enough and disappear (Garcia 2004). It is not only because of overfishing that the numbers of fish are reduced to alarming low levels; climate change, human interference in nature, habitat loss, invasive species can all cause fish to disappear from water columns (Ling et al. 2009).

Perhaps this is the reason why aquaculture has been growing in popularity in recent days, although its history is 4000 years old, going back to the days when fish in China were stored in baskets immersed in rivers (Rabanal 1988). Aquaculture is the breeding of aquatic organisms in both coastal and inland areas, involving interventions in the breeding process in order to increase production (Jhingran 1987). At present, it contributes around 10% of the total catch of inland fish in Cambodia, and has great potential to increase fish production not only in Cambodia, but in other developing countries as well. It is possible that, in the future, it will play a decisive role in fish production (Hishamunda and Subasinghe 2003). This mainly concerns the fish in highest demand, leading to their unrelenting hunting and rising prices on the market, resulting in overfishing for the sake of more money, regardless of its impact on nature (Kourous and Vleeschauer 2004).

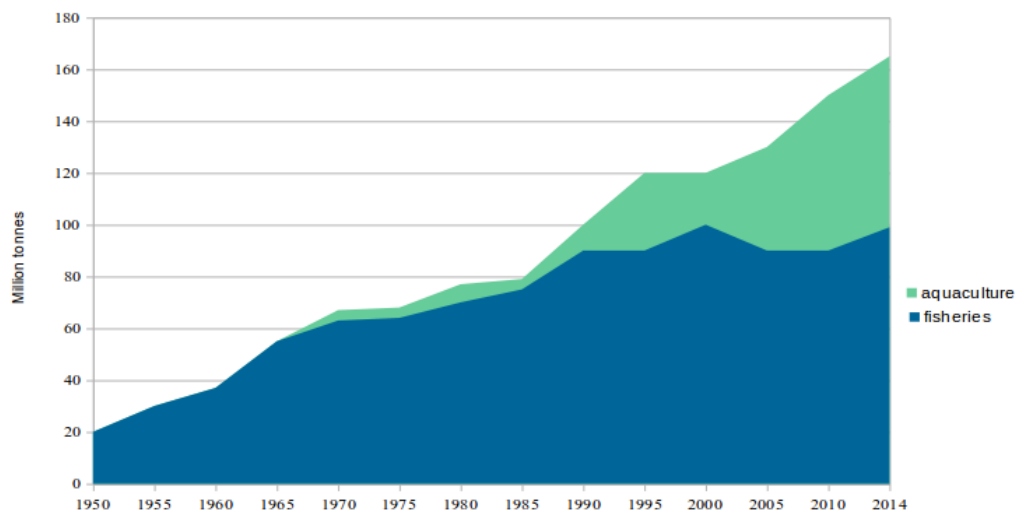


Fig. 2 Global fish production from aquaculture and wild capture, 2014

Source: Author, based on FAO, The state of world fisheries and aquaculture

Fish are an important part of Cambodian culture, mainly in traditional cuisine. Many Khmer recipe are based on rich fish stocks and fish are consumed fresh, cooked, fried, grilled (Rangers 2011), dried or fermented. Fermentation, for example, can be seen in the case of a paste called *prahok*, which can only be produced from freshwater fish, as marine species do not lend themselves well to fermentation.

Herbs and spices have been used from time immemorial to improve the flavour and also the aroma of fish. Plants provide seeds and fruits; leaves and stems; flowers and buds; roots and rhizomes; bark and resins; all of which can be sold in different forms: fresh, frozen, dried, whole or ground. Many culinary herbs are generally considered healing, as they are rich sources of phytochemicals. Phytochemicals are a large group of bioactive substances derived from plants. These protective herbal substances are believed to positively affect human health (Stadlmayr et al. 2010). Knowledge of culinary and medicinal herbs, including their production, has ensured and created employment for many people, thereby enhancing an industry that is already of great economic importance. As a result, spices are mainly produced on larger farms, rather than bought in markets. In recent years, fresh spices have become more popular than dried spices, the exact opposite of what was true in the past (Matthews and Jack 2011).

2. Literature review

2.1 The history of fishing and aquaculture

Although inland and estuary rivers are important in Southeast Asia, the Marine Region areas have been particularly important and have long provided people in these areas with different types of fish, prawns, octopuses, and many other animals that are processed as medicines, oils, jewelery and especially food. Before the beginning of the 20th century, when the countries of this region were not urbanized to a large extent, fishing was mainly focused on the need to supply households with food (Morgan and Staples 2007). The concept of supplying fresh, canned or processed fish to various markets, whether domestic or international, was largely unknown. Fishing became more and more oriented towards supplying distant markets in the late 19th and early 20th centuries (Sugiyama et al. 2004).



Fig. 3 Fishermen preparing to fish in Phnom Penh

2.2 A global overview of fishing and aquaculture

The status of wild marine resources raises concerns because since 1990 more than a quarter of fish species have been overfished in oceans and inland waters. Unfortunately, the condition of wild inland resources is not well documented (Saha et al. 2012). Chemical pollution, even at low levels, can affect fish production. They include many aspects, such as the reduction of stocks by mass mortality, changes in species composition of fish stocks or whole ecosystems, increased incidence of disease, deterioration of fish food quality and reduced growth rates. The seas and inland bodies of water receive a significant proportion of pollutant chemicals, which affect fish production (FAO 1994).

In 2002, global aquaculture produced a total of 51.4 million metric tons worth \$ 60 billion. Freshwater fish contributed 47.7% of the volume, followed by molluscs (22.9%), plants (22.6%) and crustaceans (4.2%). The contributions from aquaculture come mainly from Asia (91.2%), followed by Europe (4.0%) and America (3.6%) (Primavera, 2006). However, fish that are kept in aquaculture are at risk from external influences, mainly from diseases and ecological aspects. The incidence of the disease in recent years has influenced shrimp farming in several countries in Asia, Atlantic salmon in Chile and, for example, oysters in Europe and Global distribution of aquaculture production in countries of different ethnicity, maturity and level of economic development is still unbalanced (FAO 2016).

2.3 How fisheries and aquaculture affect the economy in Cambodia

Water is a generally an important natural resource, and many species of fish, aquatic animals and plants supply vitamins, proteins, and energy to a country's inhabitants (Sinath 2002). Cambodia is a country rich in water resources and abundant in the occurrence of fish species and their habitats (Swan and Gréboval 2003). Fishing is one of the most important industries in Cambodia, having a daily impact on local communities, as well as contributing to the nation's economy. Freshwater fishing is particularly important in the Kingdom of Cambodia,

especially in the Mekong River and the large Tonlé Sap Lake areas, which are surrounded by smaller or larger water inflows (Balzer 2002). Fish is the main source of protein in the local diet in these areas (FAO 2014). Small-scale fishing and aquaculture are an especially important source of employment all over the world. It is estimated that around 660 to 820 million people worldwide are employed wholly or partly in fishing or aquaculture (Saha et al. 2012). Total aquaculture production grew from less than two million tonnes in 1990 to more than seven million tonnes in 2005. In addition, the pace of regional development has accelerated. From 2000 to 2006, the average annual growth rate of production more than doubled from the rate between 1990 and 2000 in Southeast Asia, namely in Cambodia (Hishamunda et al. 2009).

Small-scale fishing is a very diverse and dynamic industry that varies from place to place. However, small-scale fishing suffers from many problems. The rate of catches per fisherman has fallen as population growth and the number of fishermen have exceeded the increase in catches (Petr and Welcomme 2004). The tradition of fishing is embedded in local communities and reflects local values and culture (FAO 2003). Overall, fishing and aquaculture have a positive impact on the economic face of the country (Bené et al. 2007). The Kingdom of Cambodia has a tradition of exporting freshwater fish that dates back to the 1930s. Significant species being exported include snakeheads, catfish, pangasius and marble goby, which are sold to traders in order to supply fish to the capital city of Cambodia for international export. Highly valued species of fish are predominantly sold on the international market.

2.4 Consumer preferences and fish

Price, quality, convenience, year-round availability, variety, nutritional issues, safety and hygiene are the main determinants of consumer demand for fish. Food habits and eating habits directly affect consumer interest in price and quality. The world's largest fish consumer, Japan, is more interested in fresh fish and pays the highest price. Raw fish are a staple of their diet and the Japanese generally buy fresh fish every day. There is a high demand for clean, cut, and cooked or ready-

to-eat fish and consumers are willing to pay increased premiums for them (Silva 2011).

2.5 Local agricultural markets in Cambodia

A lot of fish are consumed directly. Since caught fish deteriorate rapidly due to poor and long transport and the lack of ice, the distribution of fish from the Mekong River to more remote areas is limited. As a result of seasonal fish migrations to the Mekong River, a large difference in fish prices arises in some areas: whereas, within relatively short distances, some markets are under-supplied and prices are high, other fish markets not too far away still have ample stock (Cunningham 2005). Fisherman will either keep their catches for themselves or sell them in local markets where there is little demand. Fish market rates are among the economic factors affecting the behavior of fishermen and sellers in particular, the choice of target species. Considering that, according to economic theory, fishermen decide where and what to fish on the basis of potential profits, fluctuations in price may affect the demand for the fishing of some species. Types of fish that fetch higher market prices are therefore the most important (Baluyut 1989).



Fig. 4 Fish for sale, Central Market in Phnom Penh

2.6 The cultivation and production of spices

There is good business potential for small farmers where conditions for cultivation are favorable and there is a demand in the local market for spices and herbs. And most spices traded both in the local and international markets are produced by small farmers (Matthews and Jack 2011). Individual households can decide whether to use their gardens to make money and selling their crops to the community or keep a garden for their own consumption only. On the other hand, well-stocked products sold during a shortage period can earn a lot of money (Landon-Lane 2004). Products and practices can be chosen to suit changes in household needs and market opportunities. Climate, local food preferences and trade all affect regional differences in home gardens. In Java, Indonesia, and Sri Lanka, traditional gardens can produce 10 or more different crops: root crops, leafy vegetables, climbing vineyards, trees, etc.



Fig. 5 Herbs, spices and vegetables for sale, Old market in Siem Reap

3. Aims

The above text describes both the historical and current roles of fishing in human culture, nutrition and economics, specifically in Cambodia. Furthermore, it analyses recent trends, e.g. the decreasing of natural fish populations and negative consumer behaviour towards aquacultural products, all with respect to traditional Khmer cuisine, in which fish are consumed with specific herb species that is produced in home gardens, which are slowly disappearing particularly from urban areas due to economic, social and environmental changes in Cambodian society.

Main aim of the thesis was to understand current attitudes of Cambodian population towards fish species and culinary herbs used for preparation of fish meal. Specific objectives were to document: the first of which is to document the species of fish most used for consumption by local population in the areas surveyed. The second aim of the author is to identify plant species and herbs used for the culinary preparation of fish dishes by local households, as well as to find out where these spices are obtained markets, gardens, forests and, thirdly, to describe related social-traditions, habits, households, markets aspects. This survey, which is the first fish and plant report monitored from an economic and social point of view in this area, can serve as a reference for preserving Khmer traditions in the culinary industry.

4. Methodology

4.1 Study sites description

This research was carried out in Southeast Asia, situated on the Indochinese peninsula in Cambodia in the cities of Phnom Penh and Siem Reap. Cambodia is a nation that covers 181,040 square kilometers and consists of 24 provinces (Sunderlin 2006). Forest areas cover 12.10 million hectares of the country 67% of the total area. The cultivated area of the county is 3.78 million ha 21%, excluding areas with land mines. Rice cultivation in 1999 was conducted on 2.08 million hectares, representing 91.2% of total cultivated areas (Sinanth 2002). Cambodia has a tropical monsoon climate, which is influenced by various factors, including the country's location. It has two distinct seasons, the first being, the drought period from November to April, combined with the northeastern monsoon. February is the driest month of the year. The second season is the a rainy season, starting in May and ending in October. Everyday intensive monsoons provide water for vegetation and fresh water into rivers and lakes (Aquastat 2011).

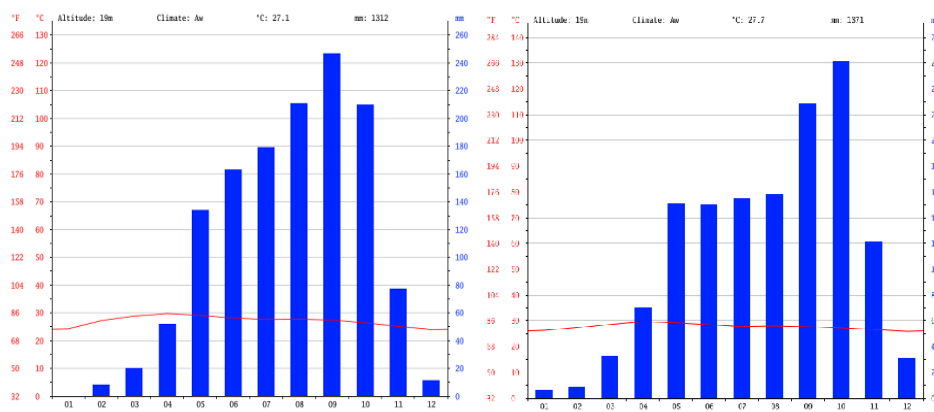


Fig. 6 The climate of Siem Reap vs. Phnom Penh

Source: Climate-Data.org

The country's topography includes three general geographic features: high mountain ranges, an extensive lowland basin with fertile farmland in the centre of Cambodia, and a prosperous waterfront, including the southern coast and a

number of rivers, which the local put to good use (Rangers 2011). The borders of present-day Cambodia are largely delimited by the natural boundaries of Thailand in the west, Laos in the north and Vietnam in the east. In the past, the demarcation of these borders has caused tension between these states, leading to much unrest and even wars.

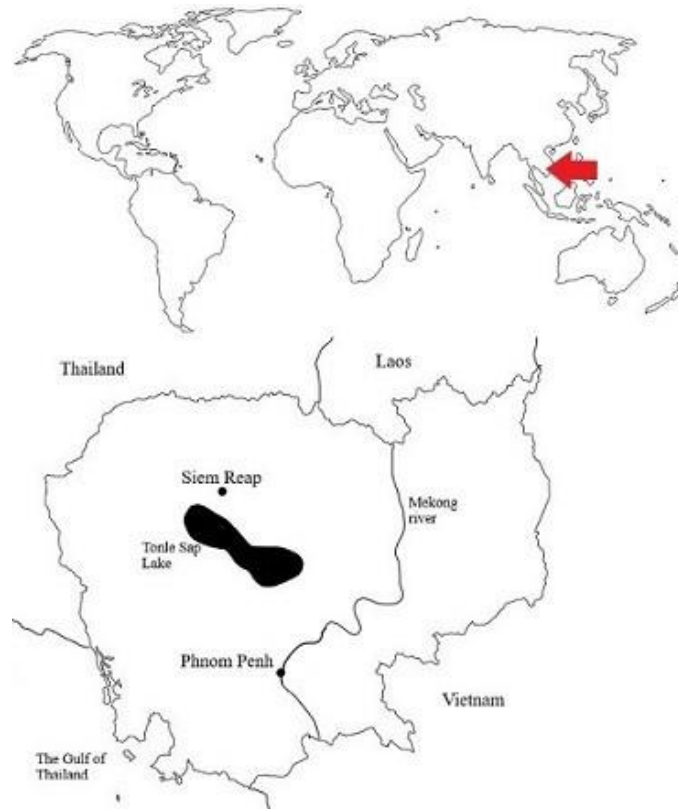


Fig. 7 Map of the world with detail of Cambodia

Source: Author, based on Blank world map

The total population of the country exceeded 16.1 million in 2017. Since 2000, the population has increased by nearly 4 million, mainly in urban areas (Rangers 2011). The population of the province of Siem Reap is around 1 million and is growing by about 2.5% every year (McKeon 2017). The city of Siem Reap is home to over 139,000 people. The capital city of Phnom Penh is the most populated in the country, inhabited by over 1.7 million people, as of 2015, when the population grew by 221,000. The least inhabited areas are on the borders of Vietnam and Thailand, with most people concentrating in the center of the country.

Table 1 Population growth from 2000-2017

Year	Population (ths.)	Annual population growth (%)	Median Age	Fertility rate	Urban population (%)	Urban population (ths.)
2017	16,005	1.54 %	24.3	2.66	21.4 %	3,431
2015	15,519	1.64 %	24.0	2.70	20.9 %	3,249
2010	14,309	1.52 %	22.7	3.08	19.9 %	2,846
2005	13,270	1.78 %	20.4	3.44	19.3 %	2,561
2000	12,152	2.67 %	18.1	4.25	18.7 %	2,272

Source: World Bank Indicators, 2018

Table 2 Population growth in Phnom Penh

Year	Population	Growth Rate (%)	Growth
2015	1,731,000	2.77 %	221,000
2010	1,510,000	2.77 %	193,000
2005	1,317,000	2.77 %	168,000
2000	1,149,000	6.57 %	313,000

Source: World population review, 2017

The Cambodian economy has grown by more than 7% annually since 2011 (Huynh et al. 2018), particularly due to the clothing industry, which accounts for 80% of the country's exports and 34% of its GDP. Other industries include construction, services, tourism and agriculture. Agriculture contributed 37% to Cambodia's GDP and employed about 67% of the workforce in 2012. Most Cambodian farmers are small landowners with less than two hectares per household. The primary economic sector is agriculture and fisheries.

The country's agricultural resources account for 3.7 million hectares of land, of which 75% is used for rice cultivation and 25% for other food and industrial

crops, especially rubber. Freshwater and saltwater fishing and water resources provide employment to more than 3 million people (FAO 2014). Rice is the main export item; other major export crops include tropical fruit, tapioca, palm sugar, and palm fruit. Other important exports include wood, textiles and clothing. The first place studied was the historic city of Siem Reap, which has reported high numbers of tourists on recent years, who come to see the mysterious of Angkor Wat temples. The city has also seen a population increase of 30% (Rangers 2011). This popular tourist destination is located along the Siem Reap River, which leads to Lake Tonle Sap, the largest freshwater lake in Asia an area of 2,700 km².

The second city visited was the capital city of Phnom Penh, located at the confluence of the Bassac, Mekong and Tonle Sap rivers, which can be considered important arteries of the country (Aquastat 2011). It is a political, economic and business center and, thanks to its central location, serves as a gateway to the entire country. That is why Phnom Penh is experiencing a large increase in the population of rural areas in the country. Despite the reconstruction taking place in Phnom Penh and the constant tide of tourists flooding Siem Reap, everyday life remains quite traditional and is mostly focused on the family (Rangers 2011).

More than 90 % of the population is ethnic Khmer; others are predominantly Cham, Chinese, Vietnamese, and Thai. The population is predominantly Buddhist, but that does not mean that other religions have no place here, as one may also encounter Hinduism or animism. Only the Cham minority is Muslim. The currency is the Cambodian riele, abbreviated as KHR; the exchange rate is: 1 USD = 4 010 KHR as of 28 February 2018 (National Bank of Cambodia 2018).

4.2 Data collection and analysis

The study was conducted over two months, from August to September in 2017, during the rainy season; first in Siem Reap, then in Phnom Penh, through personal interviews. A questionnaire was developed based on similar studies (Devadawson and Jayasinghe 2014, Benarba et al. 2015) and local conditions, tested on three respondents and then used for the whole survey. Respondents were personally

addressed in public places, mostly streets and markets, and asked to participate in the survey.

The first question was; „Do you eat fish?“ which was decisive for the questionnaire. If the answer was positive, the questionnaire could continue. Because fish is a staple of the Cambodian diet, the answer was always positive. A total of 30 respondents were approached on the street and in the markets, where the questionnaire was introduced and most of them were willing to answer questions. All interviews were conducted in the English language.

The questionnaire was composed of seven questions, five of which concerned fish, one of which pertained to spices used-for the preparation of fish, and the last of which was related to social issues in the household. The information obtained includes the name of the fish species and spices, origin, market price, importance of origin, and also information on the household of the participant, such as the number of household members, gender, age and years of schooling. The responses to the questionnaires were entered into a Microsoft Excel spreadsheet and processed with descriptive statistical analysis.

5. Results

5.1 Fish species consumed by respondents

The study documented twenty-one fish species from fourteen families regularly consumed by our respondents. The most common fish were Giant snakehead from the Channidae family, which was found in the Mekong River, Wallago species of the Siluridae. The third most commonly consumed to fish was the Blue gill of the Centrarchidae family. All of these fish originate in freshwater habitats such as rivers or lakes.

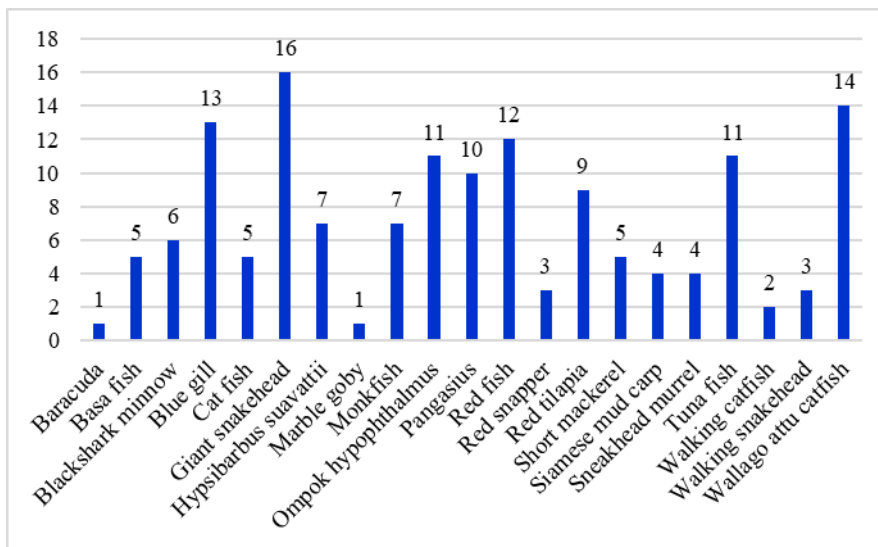


Fig. 8 The most commonly consumed fish in Siem Reap and Phnom Penh

The average price of fish per kilogram, regardless of species, was three U.S. dollars. There was a price difference between fresh and dried fish, where dried fish were more expensive in comparison to fresh fish. In response to the question of whether the source of the fish they consume is important, the participants' answers were clearly affirmative in twenty-eight situations. In two of these answers, the price of fish was mentioned as well.

Table 3 An overview of the fish species mentioned in the questionnaire

Fish species		Origin			Market			Price			
English name	Latin name	Family	Lake	River	Sea	Fish farm	Fishing	Fresh	Dried	Fresh USD/kg	Dried USD/kg
1	Barracuda	<i>Sphyraena barracuda</i>				x		x		4.00	
2	Basa fish	<i>Pangasius bocourti</i>		x				x		0.25	0.50
3	Blackshark minnow	<i>Labeo chrysophekadion</i>	x				x	x		1.50	
4	Bluegill	<i>Lepomis macrochirus</i>	x				x	x		1.50	3.00
5	Cat fish	<i>Siluriformes</i>		x			x	x		0.80	
6	Giant snakehead	<i>Channa micropeltes</i>	x				x	x		0.60	
7	Hypsibarbus suvattii	<i>Hypsibarbus suvattii</i>	x				x	x		5.00	
8	Marble goby	<i>Oxyeleotris marmorata</i>		x			x				
9	Monkfish	<i>Lophius</i>			x		x	x		3.00	
10	Ompok hypophthalmus	<i>Ompok hypophthalmus</i>	x					x	x	5.25	6.00
11	Pangasius	<i>Pangasius hypophthalmus</i>		x			x	x		1.50	
12	Red fish	<i>Sebastes</i>			x			x	x	3.00	5.00
13	Red snapper	<i>Lutjanus campechanus</i>			x		x	x	x	4.00	5.00
14	Red tilapia	<i>Oreochromis</i>				x	x	x	x	4.00	6.00
15	Short mackerel	<i>Rastrelliger brachysoma</i>			x			x		7.00	
16	Siamese mud carp	<i>Henicorhynchus siamensis</i>		x			x				
17	Sneakhead murrel	<i>Channa striata</i>	x				x				
18	Tuna fish	<i>Thunnini</i>			x			x	x	4.00	5.00
19	Walking catfish	<i>Clarias batachus</i>		x							
20	Walking snakehead	<i>Channa orientalis</i>	x				x				
21	Wallago catfish	<i>Wallago attu</i>	x				x	x	x	1.00	2.00

According to the respondents, the most important criterion when buying fish is cleanliness, with an emphasis on the fact that the fish are not defective in any way and have been properly stored. Other important factors include flavour and the price, since locals do not make much money, they have to pay attention to prices. An answer that some respondents mentioned was that fish are important for their positive effect on the human body.

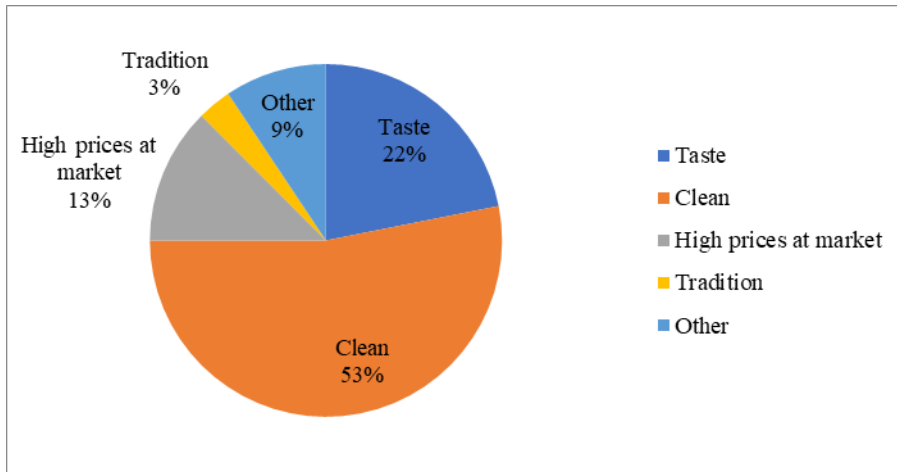


Fig. 9 Why the sourcing of fish is important for respondents

Regarding the fish species mentioned in response to the questionnaire, it has been confirmed that in the monitored areas, fish are sourced most often from rivers, then lakes, then the sea, and, lastly, fish farms.

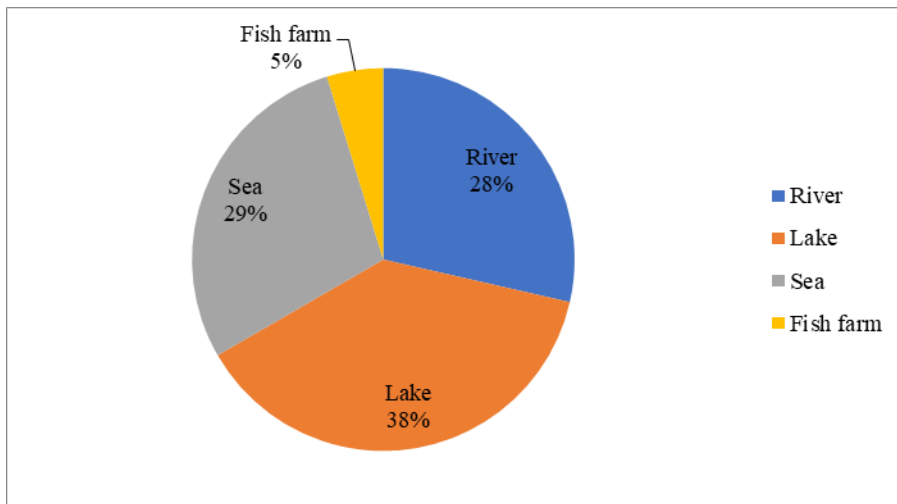


Fig. 10 Sources of fish

It is obvious that fishing is a common means of getting food, but research has shown that many people prefer going to markets, where they can choose from a huge variety of fish, both fresh and dried. According to respondents, fresh fish are more popular than dried fish.



Fig. 11 Dried fish at the Central Market



Fig. 12 Fresh fish on ice

5.2 The most common herbs and spices used as seasoning by respondents

According to the ethnobotanical data collected, there are twenty-five plant species that can be divided into fifteen families. The most common family is Amaryllidaceae with four species, followed by the families of Brassicaceae, Fabaceae and Solanaceae, represented by three species each. Apiaceae, Lamiaceae and Poaceae are represented by two each species and the families of Arecaceae, Bromeliaceae, Convolvulaceae, Cucurbitaceae, Piperaceae, Rutaceae and Zingiberaceae are represented as well.

The average price per kilogram of herbs was around one U.S. dollar. The plant, that appeared in all but three of the responses is *Cymbopogon citratus* (i.e. lemongrass) from the Poaceae family. It is, the most commonly mentioned spice, and it plays an important role in both the processing of the fish and in common food preparation. Due to its ease of cultivation, it is found in many local gardens, and is therefore the most commonly used spice in the monitored areas. Lemongrass is, followed in popularity by chillies, from the family Solanaceae, and basil, from family Lamiaceae.

Table 4 An overview of herbs, spices and vegetables from questionnaire

Types of spice		Origin			Price	
English name	Latin name	Family	Garden	Market	Forest	
					USD/kg	
1	Bamboo	<i>Bambusa vulgaris</i>	Poaceae	x		
2	Basil	<i>Ocimum basilicum</i>	Lamiaceae	x	x	0.50
3	Beans	<i>Phaseolus vulgaris</i>	Fabaceae		x	1.00
4	Broccoli	<i>Brassica oleraceae</i> var. <i>italica</i>	Brassicaceae		x	2.00
5	Carrot	<i>Daucus carota</i>	Apiaceae	x	x	1.00
6	Cauliflower	<i>Brassica oleracea</i> var. <i>botrytis</i>	Brassicaceae		x	2.00
7	Coconut	<i>Cocos nucifera</i>	Arecaceae		x	1.00
8	Coriander	<i>Coriandrum sativum</i>	Apiaceae	x		
9	Cucumber	<i>Cucumis sativus</i>	Cucurbitaceae	x	x	1.50
10	Eggplant	<i>Solanum melongena</i>	Solanaceae	x	x	1.00
11	Garlic	<i>Allium sativum</i>	Amaryllidaceae		x	1.00
12	Ginger	<i>Zingiber</i>	Zingiberaceae	x	x	2.00
13	Chilli	<i>Capsicum anuum</i>	Solanaceae	x	x	1.00
14	Chinese cabbage	<i>Brassica chinensis</i> <i>Allium</i>	Brassicaceae		x	1.50
15	Chives	<i>schaenoprasum</i> <i>Cymbopogon</i>	Amaryllidaceae		x	0.25
16	Lemongrass	<i>citratius</i>	Poaceae	x	x	0.50
17	Lime	<i>Citrus limetta</i>	Rutaceae		x	1.50
18	Long beans	<i>Vigna unguiculata</i> ssp. <i>sesquipedalis</i>	Fabaceae		x	0.75
19	Morning glory	<i>Ipomoea puryurea</i>	Convolvulaceae		x	0.75
20	Onion	<i>Allium cepa</i>	Amaryllidaceae	x	x	0.50
21	Pepper	<i>Piper sativum</i>	Piperaceae		x	1.50
22	Pineapple	<i>Ananas comosus</i>	Bromeliaceae		x	0.50
23	Shallots	<i>Allium ascalomicum</i>	Amaryllidaceae	x	x	0.50
24	Tamarind	<i>Tamarindus indica</i> <i>Solanum</i>	Fabaceae			x
25	Tomato	<i>lysopersicum</i>	Solanaceae	x	x	1.50

The gathered data clearly show that spices and herbs are often bought at local markets, and quite a few respondents are also cultivating their own ingredients for fish preparation. Few people are looking to forests for spices and herbs at the present time, as they could be confused and poisoned by plants that are similar to domesticated varieties.

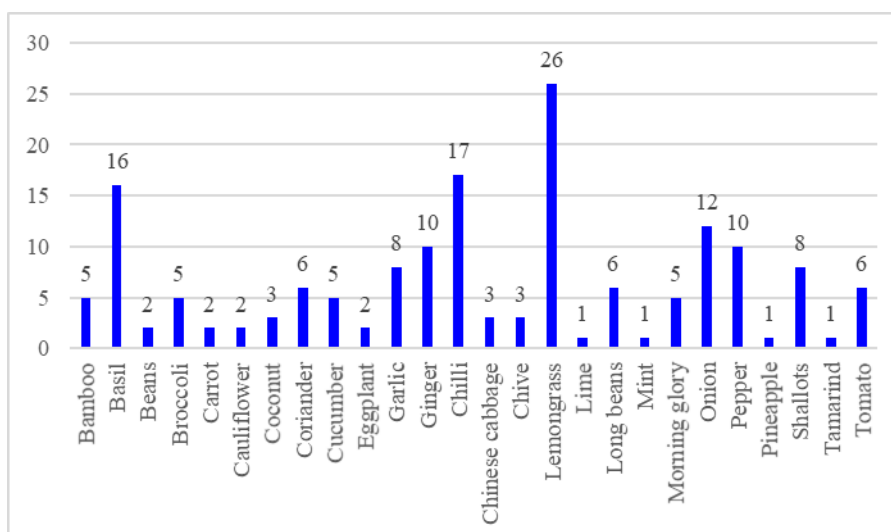


Fig. 13 The most common herbs in Siem Reap and Phnom Penh

5.3 A breakdown of local households

From the sociological point of view, it is possible to say that fishing is exclusively a male activity, and that there is at least one fisherman in each family. In contrast, the cultivation or purchase of spices or herbs is reserved exclusively for women. The average age of males and females in the monitored areas is the same for both sexes, Averaging around thirty-one years.

Table 5 Socio-economic profile of households

	Profile of households			HH head age	Average age	HH head Years of schooling	Average years Years of schooling
	HH size	Male	Female				
1	5	2	3	36	38.00	16	5.80
2	6	1	5	26	18.50	12	4.00
3	6	3	3	57	35.00	0	7.50
4	8	4	4	53	36.88	0	4.75
5	7	3	4	31	18.86	12	9.14
6	5	3	2	31	14.80	12	5.00
7	9	3	6	38	35.44	0	4.44
8	6	2	4	30	29.00	16	6.67
9	7	4	3	56	31.43	0	4.57
10	6	4	2	37	33.67	16	6.29
11	8	6	2	36	28.63	0	3.50
12	5	2	3	40	27.00	12	10.80
13	7	3	4	30	27.14	16	5.43
14	4	2	2	24	40.00	12	7.50

	Profile of households			HH head age	Average age	HH head Years of schooling	Average years Years of schooling
	HH size	Male	Female				
15	7	4	3	44	27.43	0	5.14
16	8	2	6	48	30.63	0	4.13
17	6	4	2	45	35.00	0	7.83
18	8	4	4	30	21.38	0	4.00
19	4	2	2	28	26.75	0	9.00
20	5	2	3	54	34.00	5	9.00
21	7	2	5	29	27.29	16	7.00
22	7	3	4	26	29.57	12	5.00
23	5	3	2	28	38.20	14	5.20
24	7	4	3	28	30.57	16	7.29
25	5	4	1	31	40.40	0	4.60
26	9	3	6	51	39.78	0	5.89
27	6	3	3	32	38.83	12	8.00
28	6	4	2	30	34.67	0	6.00
29	7	4	3	36	35.57	12	8.57
30	6	4	2	27	30.83	0	4.00

The most common job mentioned in the questionnaire was „salesperson“ selling anything from food to clothing, followed by „student“. While students have to make money, it is evident that education is very important to the Khmers as a means to access better jobs and higher earnings. The third most common occupation was „driver“; the tourist industry is booming and tourists are flocking to Cambodia, so the demand for drivers is growing.

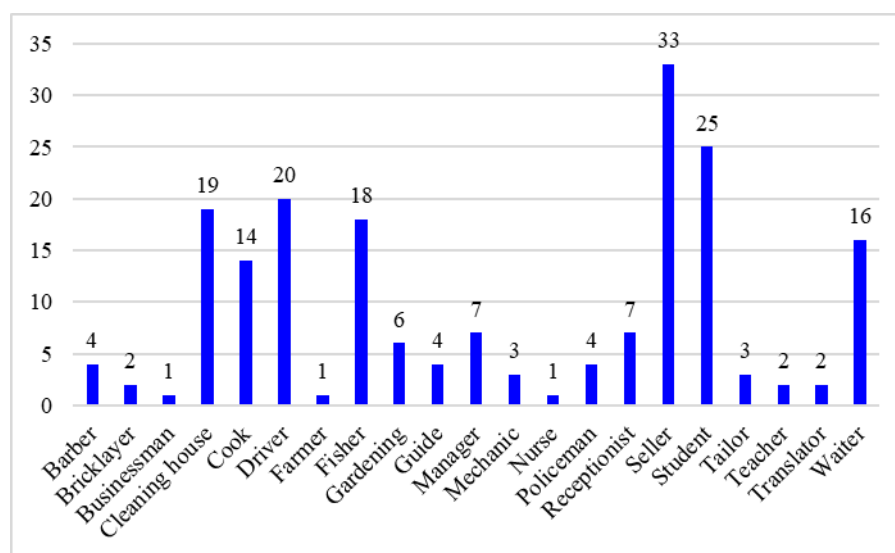


Fig. 14 The most common occupation of respondents' household members

6. Discussion

According to other studies (Devadawson and Jayasinghe 2014, Benarba et al. 2015), the data collected are sufficient to provide accurate results. As it was a short-term survey that lasted two months, the responses met their purpose and the identification of twenty-one species of fish from fourteen families and twenty-five species of spices or herbs from fifteen families were gathered from a large enough sampling to identify the three most widely used fish and spices characteristic of Khmer cuisine. These fish have been eaten in Cambodia from time immemorial and are an inherent part of everyday meals, and it can also be said that they occupy a similar position to the rice that is present at nearly every meal, including breakfast.

Fish have an indispensable place in the world of food, especially in developing countries, and are an important source of protein and vitamins. The fish species that were most popular in the capital and Siem Reap were the most accessible, coming from lakes and rivers that are close to human settlements. Types of fish in Asian cuisine are consumed that are common to all areas of cuisine, including soup, snack and main dishes.



Fig. 15 Spicy redfish soup



Fig. 16 Barracuda as a main dish

The most commonly caught species in the area are freshwater fish, as there are huge water resources around Siem Reap and Phnom Penh, that are home to hundreds of fish, making fish dishes one of Cambodia's main traditions. The fish are hunted exclusively by men who have been practicing this craft since childhood; in contrast, women sell everything from food to, clothes to jewelry. They also have to maintain the garden, grow plants and ingredients for food preparation, preparing dishes for the family, and look to the running of the household. Therefore, they have a very important role in the household, but the primary breadwinner is always an adult man.

The most commonly mentioned fish on the survey was the giant snakehead, which is found in Lake Tonle Sap. The Latin name is *Channa micropeltes* and it comes from the Chanidae family. Haddocks make up over 30 species of the genus *Channa*, which occur in southern and eastern Asia. Snakeheads are very unattractive to water quality and highly adaptable. They are predators who feed on many prey of reasonable size, including fish, smaller invertebrates, and larger vertebrates like frogs. Most are large fish, which in their native habitats normally serve as consumers, as in Cambodia, Thailand and Taiwan. Most species grow to be 25 to 40 cm as adults, but there are also species that grow to 80 to 100 cm in length. The most well-known of these larger species is the giant snakehead. Not only are they fished, are also farmed via in aquaculture (Hofmann 2016).



Fig. 17 Giant snakehead ready at the market for sale

Wallago catfish is shares the spot for second most popular fish from the questionnaire. Its Latin name is *Wallago attu* and is part of the Siluridae family. This type of fish lives in large lakes, rivers and reservoirs. It is a predatory catfish that thrives in grassy margins, preferring calm waters and slower currents where there is plenty of mud. At the beginning of its life, it feeds on insects and, over time, moves on to bigger prey such as fish, crustaceans and mollusks (Bloch and Schneider 1801).

The third most consumed fish is bluegill, which comes from the family Centrarchidae and bears the Latin name *Lepomis macrochiru*. This fish lives in the shallow waters of many lakes and ponds, and can also be found in streams and small rivers, preferring waters with aquatic plants and weeds where it can hide. In summer, adults move into deep, open water, where they well just below the surface and feed on plankton. Bluegills typically range in size from about 10 to 30 cm and can reach a maximum size of 41 cm (Flammang and Lauder 2008).

The most popular seasoning paired with fish in this area is lemongrass. This plant known also by its Latin name, *Cymbopogon citratus*, or, in English, lemongrass. It is a perennial grass originating from Ceylon and southern India. Plants of the *Cymbopogon* genus are tropical. Spice This herb comes from the Poaceae family. It grows in thick tufts, reaching a height of 120 to 150 cm.



Fig. 18 Lemongrass in a bunch

All parts of the plant have a strong lemony aroma and are therefore used to season many dishes, especially in Asian cuisine. Lemongrass is widely used in Asian cuisine and is an indispensable part of their meals for many households. This cuisine is known for its rice dishes, soup, curry, pork, fish and seafood. Lemongrass leaves can be used to prepare delicious lemon tea. In its native habitat, this tea is recommended for the treatment of gastric and nervous ailments, fever, malaria, and flu. It is also known as an oleaginous grass, which plays a role in the production of aromatic essential oils, including citronella oil, which are used in perfumes and as natural insecticides (Krulich 2007). Enjoying widespread use, it is a very popular herb not only in Cambodia and Asian states, but all over the world. In addition to its culinary, fragrance and insecticidal uses, it has been shown that the essential oils of some species have antimicrobial and antiviral properties (Chao et al. 2000).

Chilli peppers (*Capsicum annuum*) in Latin, come from the Solanaceae family. They are widely used in many cuisines as spices and seasonings. The substances that give chilli peppers their intensity when ingested are capsaicin and related compounds known as capsaicinoids. These peppers most likely originated in Mexico. Chilli peppers are being used fresh or dried. Chillies are dried to preserve them for a long time, and, if dried properly, also to improve their sensory qualities such as taste, colour and vitamins (Banout et al. 2011). The leaves of plants from genus *Capsicum* are edible. Although almost all other plants of the Solanaceae family have toxins in their leaves, chilli peppers do not. The leaves are slightly bitter and can be cooked and served as vegetables in many cultures, such as Japan (Douglas et al. 2005).

Basil is known all over the world and belongs to the family Lamiaceae with the Latin name *Ocimum basilicum*. This native to India. From there, it began to spread all over the world in ancient times and soon had many enthusiastic admirers. Today, we consider basil a very tasty and distinct aromatic herb. In addition, it is also on the list of medicinal herbs and can be used to treat various diseases. The substances contained therein encourage, for example, the secretion

of gastric juices. Basil is an easy herb cultivate. It thrives in warm and sunny weather (FAO 2017).



Fig. 19 Wide range of spices and vegetables

These valuable data could not only serve as a source of information for local authorities in the future, but also for the general public to learn about the customs and traditions of Khmer culture. The results of this research could also serve as the basis for other studies of similar stamping. The information and knowledge accumulated herein can also serve to document and preserves the tradition of Khmer cuisine, specifically in regard to fish consumption and the use of local seasoning.

7. Conclusion

As the research presented herein is focused mainly on communities in urban areas where many rivers, streams and lakes are found, most of the fish species mentioned by respondents come from freshwater sources. This thesis documents twenty-one species of fish, six of which dwell in rivers (28%), eight of which dwell in lakes (38%), six of which come from the sea (29%) and only one which is farmed (5%). According to respondents, aquaculturing has not yet become as popular a source of fish in Cambodia as it has in neighboring countries. The most common type of fish noted in participants' responses was the giant snakehead of the Mekong River, which serves as a great source of fish for countries in Southeast Asia, including Cambodia. This species can be seen in local markets—in most stalls selling fish, prices for this species are around one USD. Other fish that are worth mentioning are the Wallago attu and the bluegill. However, all fish identified are indispensable to local cuisine. Not only are there a lot of independent fishermen in the country who fish for personal use and depend on natural resources for survival, but there are also many retailers offering a variety of fish and providing new catches to consumers daily. According to participants' responses, freshness is the most important characteristic when purchasing fish (53%), followed by taste (22%), which is a very important factor for all cultures. Another aspect people pay attention to when purchasing fish is the market price (13%), which is no wonder, considering that Cambodia is still the poorest country in Southeast Asia. Another factor is the fact that fish provide many health benefits (9%). Finally, the area's long tradition of fishing (3%) also plays a role in consumers' decision to purchase fish. As seasonings are an important part of the preparation of fish, the study also documents spices and herbs that are commonly used in the preparation of fish dishes. The most common herb is lemongrass, which is indigenous to Asia and is very popular all over Cambodia. It is grown by the locals in gardens big and small because it is used in the preparation of fish and many other dishes. Other popular seasonings include chili and basil. Fish itself is used to add flavors to many vegetables, from cucumbers to cauliflowers.

References

- Baluyut E. 1989. Aquaculture systems and practices: a selected review, Rome
- Balzer P. 2002. Biodiversity and the ecosystem approach in agriculture, forestry and fisheries. Ninth Regular Session of the Commission on Genetic Resources for Food and Agriculture, Rome
- Banout J, Havlík J, Lojka B, Polesný Z, Verner V. 2011. Design and performance evaluation of a Double-pass solar drier for drying of red chilli (*Capsicum annum* L.). Solar Energy, Prague
- Benarba B, Belabid L, Righi K, Bekkar A, Elouissi M, Khaldi A, Hamimed A. 2015. Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). Journal of Ethnopharmacology, Mascara
- Béné C, Macfadyen G. A. 2007. Increasing the contribution of small-scale fisheries to poverty alleviation and food security, Rome
- Cunningham L. 2005. Assessing the contribution of aquaculture to food security: a survey of methodologies. St Andrews University, St Andrews
- Devadawson Ch, Jayasinghe Ch, Sivakanesan R. 2015. Socio-demographic factors and fish eating trends in eastern community, Sri Lanka. Journal of Experimental Biology and Agricultural Sciences, Sri Lanka
- FAO. 1994. Sustainable development and the environment. FAO, Stockholm 1972 - Rio 1992
- FAO. 2001. Production, Accessibility, Marketing and Consumption Patterns of Freshwater Aquaculture Products in Asia: A Cross-Country Comparison. FAO, Rome Available from <http://www.fao.org/publications/card/en/c/31957848-cb70-5c87-8433-e1b3c559ffb3/> (accessed November 2017)

- FAO. 2003. New Approaches for the Improvement of Inland Capture Fishery Statistics in the Mekong Basin. RAP Publications, Bangkok Available from <http://www.fao.org/apfic/publications/detail/en/c/419620/> (accessed January 2018)
- FAO. 2003. Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries. FAO, Rome Available from <http://www.fao.org/docrep/007/ad525e/ad525e00.htm> (accessed January 2018)
- FAO. 2003. Report and Documentation of the international workshop on the implementation of international fisheries instruments and factors of unsustainability and overexploitation in fisheries. FAO, Mauritius Available from <http://www.fao.org/docrep/007/y5242e/y5242e00.htm> (accessed December 2017)
- FAO. 2007. Brief on national forest inventory Cambodia. FAO, Rome Available from <http://www.fao.org/docrep/016/ap183e/ap183e.pdf> (accessed January 2018)
- FAO. 2011. Cambodia. FAO, Rome Available from http://www.fao.org/nr/water/aquastat/countries_regions/KHM/print1.stm (accessed January 2018)
- FAO. 2011. Fishery and Aquaculture Country Profiles the Kingdom of Cambodia. FAO Available from <http://www.fao.org/fishery/facp/KHM/en> (accessed November 2017)
- FAO. 2011. Fishery value chain analysis in Cambodia. FAO, Rome Available from <http://FAO.org> (accessed December 2017)
- FAO. 2014. The State of World Fisheries and Aquaculture. FAO, Rome Available from <http://www.fao.org/3/a-i3720e.pdf> (accessed December 2017)

- FAO. 2016. THE STATE OF WORLD FISHERIES AND AQUACULTURE.FAO, Rome Available from <http://www.fao.org/3/a-i5555e.pdf> (accessed November 2017)
- FAO. 2017. Joint fao/who food standards programme codex committee on spices and culinary herbs. FAO, Rome
- FAO. National Aquaculture Sector Overview Cambodia. FAO Available from http://www.fao.org/fishery/countrysector/naso_cambodia/en (accessed December 2017)
- Garcia S. M. 2003. The ecosystem approach to fisheries. University of Montpellier 2. Montpellier
- Hishamunda N, Subasinghe R. P. 2003. Aquaculture development in china the role of public sector policies. FAO Fisheries Department, Rome
- Hofmann Jaroslav. 2016. Hadohlavci. Chovatel magazine, Prague
- Jakub Krulich. 2007. Rostliny: Cymbopogon citratus-citronová tráva, Zahradnictví J. a Z. Krulichovi, Prague Available from <https://www.garten.cz/a/cz/2779-cymbopogon-citratus-citronova-trava/> (accessed February 2018)
- Jhingran V. G. 1987. Introduction to aquaculture. Nigerian institute for oceanography and marine research, Lagos
- Kourous G, Vleeschauwer D. 2004. Overfishing on the increase in Asia-Pacific seas. FAO report, Bangkok
- Landon-Lane Ch. 2004. Livelihood grow in gardens diversifying rural incomes through home gardens. Agricultural Support Systems Division, Rome

- Landon-Lane Ch. 2011. Livelihoods grow in gardens, Rural Infrastructure and Agro-Industries Division. Rome
- LAO PDR. 1998. Flood management and mitigation in the mekong river basin. RAP Publication, Vientiane
- Lemon Grass Available from <http://nhb.gov.in/model-project-reports/Horticulture%20Crops/Lemongrass/Lemongrass1.htm> (accessed October 2017)
- Linga S. D, Johnsona C. R, Frusherb S. D, Ridgwayc K. R. 2009. Overfishing reduces resilience of kelp beds to climate-driven catastrophic phase shift. Pontificia Universidad Catolica de Chile, Santiago
- Matthews M, Jack M. 2011. Spices and herbs for home and market. Rural Infrastructure and Agro-Industries Division, Rome
- McKeon A. 2017. Population, Siem Reap. Available from <https://www.siemreap.net/visit/about-siem-reap/info/siem-reap-population/> (accessed February 2018)
- Morgan G, Staples D, Funge-Smith S. 2007. Fishing capacity management and IUU fishing in Asia. RAP Publication, Bangkok
- Museum of Comparative Zoology. 2008. Speed-dependent intrinsic caudal fin muscle recruitment during steady swimming in bluegill sunfish *Lepomis macrochirus*. Harvard University, Cambridge
- Nathanael H, Bueno P, Ridler N. 2009. Analysis of aquaculture development in Southeast Asia. FAO, Rome
- National Bank of Cambodia. Daily exchange rate Available from: <https://www.nbc.org.kh/english/> (accessed February 2018)

New Hampshire Fish and game. Brook Trout Available from:
<http://www.wildlife.state.nh.us/fishing/profiles/brook-trout.html> (accessed
March 2018)

Ng, H.H. Wallago attu. 2010. The IUCN Red List of Threatened Species
Available from <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166468A6215731.en>. (accessed March 2018)

Primavera J. H. 2006. Overcoming the impacts of aquaculture on the coastal zone.
Aquaculture Department, Southeast Asian Fisheries Development Center,
Tigbauan

Rabanal H. R. 1988. History of aquaculture. Coastal Fisheries Development
Project, Manila

Rangers T. 2011. National Geographic traveler: Cambodia. National Geographic
Society, Washington, D.C.

ROBERTS M. 1983. Book of herbs: the medicinal and culinary uses of herbs in
South Afrika. PRETORIA: JONATHAN BALL PUBLISHERS, Pretoria

Saha J, Sanders J, Spaul J, Van Acker J. 2012. The state of world fisheries and
aquaculture 2012. Viale delle Terme di Caracalla, Rome

Silva D. 2011. Value chain of fish and fishery products: origin, functions and
application in developed and developing country markets. Rome

Silva E, Kimie L, Santos J, Girnos J, Antunes J, Kanamaru L, Marília F. 2012.
Relationship between the price of fish and its quality attributes: a study within
a community at the University of São Paulo, Brazil. Food Science and
Technology, Campinas

- Sinanth Ch. 2002. Investment in land and water. Proceedings of the Regional Consultation, Bangkok
- Stadlmayr B, Persijn D, Mouille B, Charrondiere R. 2010. Phytochemicals in the FAO/INFOODS Food Composition Database for Biodiversity, Rome
- Sugiyama S, Staples D, Funge-Smith S. 2004. Status and potential of fisheries and aquaculture in Asia and the Pacific. RAP Publication, Bangkok
- Swan J, Gréboval D. 2003. Report and documentation of the International Workshop on the Implementation of International Fisheries Instruments and Factors of Unsustainability and Overexploitation in Fisheries. FAO Fisheries Report, Mauritius
- UNIDO and FAO. 2005. Post-harvest operations in developing countries, Rome Available from <http://www.fao.org/3/a-ad420e.pdf> (accessed January 2018)
- Welcomme R, Petr T. 2004. Proceedings of the second international symposium on the management of large rivers for fisheries. RAP Publication, Bangkok