

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences



Czech University of Life Sciences Prague

**Faculty of Tropical
AgriSciences**

Master's Thesis

Consumers attitudes to aquatic vegetables in Cambodia

Prague 2019

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Acknowledgement

First and most I would like to thank my supervisor Ing. Petra Chaloupková, Ph.D., for patient, helpful comments and advices. She guided me to achieve all goals which we set up together for the Master thesis and helped me improve my skills in calm and motivation way. I got opportunity to make my survey in Cambodia thank to her support and got new kind of experiences from the field.

I would like to express my appreciation the Faculty of Tropical AgriSciences for opportunity to participate the Summer School at the Royal University of Agriculture in Cambodia. The Summer School gave me the chance to meet local students. I would like to thank especially to Kimsrean Eang, who helped me a lot with translation questionnaire to Khmer language and directly in the field with survey, due to her support I could achieve such a high number of respondents.

Last but not least, words of thanks go to my family, boyfriend and friends who support me whole time and motivated me.

Declaration

“I Kristýna Odehnalová hereby declares that this thesis entitled Consumers attitude of aquatic vegetables in Cambodia, is my own work and all the sources have been quoted and acknowledged by means of complete references.”

In Prague

(Signature of student)

B. Sc. Kristýna Odehnalová

Abstract

Aquatic vegetables are highly consumed across the whole country of Cambodia with needs in region of 500 tonnes vegetables per day. Nowadays often discussed topic regarding to aquatic vegetables was toxicity of heavy metals in wet lands. Aquatic vegetables are highly cultivated in these wet lands which have function in the same time as removal of pollutants from Phnom Penh city before the waste water eventually flowed into the Mekong River. The main objectives of the study were to get relevant information about aquatic vegetables in term of consumption and relation with socio-demographic characteristics and evaluation of consumers' awareness of health consequences. The study area was determined for the highest concentration of consumers and the sample size reached 393 respondents in productive age (from 15 to 65). The data were collected via convenience sampling method and snow-ball sampling method through structured questionnaire survey. To determine relationship between socio-demographic characteristics, opinion of respondents to food security and consumption of individual aquatic vegetables Pearson Chi-squared test was applied. The study showed that the most common type of aquatic vegetables was Water convolvulus which was highly consumed by all respondents. Most of the respondents reported low awareness of potential health risk relevant to waste water flowed to wet lands where aquatic vegetables were commonly cultivated. However, respondents' opinions relevant to the food security were statistically significant for consumption of aquatic vegetables. The Pearson Chi-squared test results showed significant differences between particular socio-demographic characteristics especially in cases of education level and occupation. The study recommends that there is need to increase knowledge about toxicity of heavy metals and quality of wet lands where vegetables are cultivated to eliminate health problems.

Keywords: Consumer attitude, Aquatic vegetables, Food security, Cambodia

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List of the Abbreviations

ADB	Asian Development Bank
CM	Cambodian mint
CSES	Cambodia Socio-Economics Survey
CFSVA	Comprehensive Food Security and Vulnerability Analysis
EEPSEA	Economy & Environment Program for South East Asia
FAO	Food and Agriculture Organization of United Nations
FM	Fish Mint
GDP	Gross Domestic Product
IISD	International Institute for Sustainable Development
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry, and Fisheries
OECD	The Observatory of Economic Complexity
USD	United States Dollar
WC	Water convolvulus
WD	Water dropwort
WHO	World Health Organization
WM	Water mimosa
WFP	World Food Programme

1. Introduction

The agriculture sector still plays important role for Cambodia's economy not just in term of rural areas but agriculture sector still employs almost 50% of whole population in Cambodia (MAFF 2015). Economy in Cambodia has been one of the fastest-growing over the past 5 years in the Southeast Asia. The Asian Development Bank mentioned, that this progress was main reason why country's poverty fell rapidly down from 47.8% in 2007 to 13.5% in 2014. Even though more than 70% of Cambodians are still living on less than \$3 per day (ADB 2016). According to the Cambodia's Centre for Policy Studies (2017), the country imports anywhere between 200 to 400 tonnes of vegetables from neighbouring countries every day what means that local farmers are losing four-fifths of consumers, because exactly this amount took foreign vegetables (Miller 2017). Rural households are less dependent on the food market about 65% of food commodities are purchased in markets, because they are still able to produce food to feed their families, on the other hand, for urban households 93% is purchased (El-Noush 2010). The capital of Cambodia, Phnom Penh has a population of one and half million people and most of the urban domestic and industrial waste water drains to the Boeung Cheung Ek Lake/wetland. The sewerage and waste water treatment facilities to serve this population are seriously inadequate (JICA 1999). Cultivation of aquatic vegetables is an important activity that sustains the livelihoods of many families around lakes in Cambodia. The official functions of the Beung Cheung Ek wetlands are flood control and removal of pollutants from Phnom Penh city before the water eventually flows into the Mekong River. High metal concentrations were found in waste water sludge especially lead and mercury, which is as the untreated effluent of more than 3,000 industries drains into BC Ek Lake (Muong 2004). The Ministry of the Environment of Cambodia reported that 20% of the total daily vegetables consumption of Phnom Penh is from aquatic vegetables from the waste water lake within the city (Hoek et al. 2005). Therefore, aquatic vegetables are highly consumed in whole Cambodia, currently, there are not many researches focused on consumption of aquatic vegetables or health impact of consumption these

vegetables according to wetlands with high amount waste water and food security. This study is designed to find out consumers attitudes to aquatic vegetables and opinion of respondents to health conscious of these vegetables. This research was focused on five species of aquatic vegetables – Water convolvulus, Water dropwort, Water mimosa, Fish mint and Cambodian mint.

2. Literature review

2.1 Importance of agriculture in Cambodia

The agriculture sector dominates in Cambodia's economy not just for population living in rural areas but agriculture production as food or family income is backbone of economy in whole Cambodia (MAFF 2015). This fact is also visible in comparison with employability in the services and industry sectors which were 38% and 19.6% in 2017 and agriculture sector alone employs almost 50% of population (World Bank 2018). The Royal government of Cambodia has vision to modernize Cambodia's agriculture through increase value added in this sector, competitive products in the global market and promote agriculture value chain which is responsiveness to market demand (MAFF 2015).

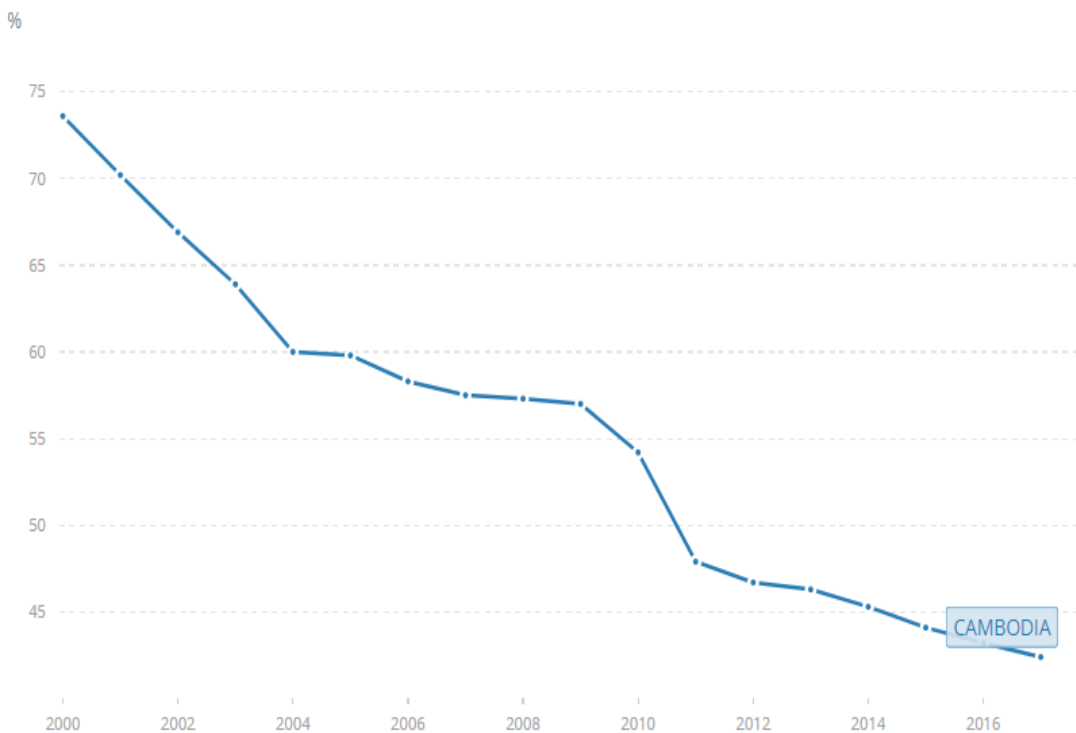
Agriculture gross production grew mainly by crop production between years 2004 and 2012 by 8.7%. In the last decade, tendency is that larger farms which owner more than 3 ha became larger and small farms which are counted as less than 1 ha became smaller (World Bank 2015). In 2013 it was found that 1.9 million households had agriculture holdings, what must be at least two large livestock or three small livestock or 25 poultry or land equal to 300 square meters what is visible example how important agriculture is in Cambodia through whole population (Open Development 2016).

Nowadays number of plantations are increasing, and the Ministry of Agriculture, Forestry, and Fisheries is searching for opportunities to have higher quality of the product what is mentioned as higher quality seeds, new technology, fertilizers and training for farmers. Council for the Development of Cambodia reported that in Cambodia is increasing also opportunity to get better access to global market (MAFF 2018).

2.2 Economics and role of agriculture

Economy in Cambodia has been one of the fastest-growing over the past 5 years in the Southeast Asia. Asian Development Bank mentioned, that this progress was main reason why country's poverty fell rapidly down from 47.8% in 2007 to 13.5% in 2014. Even though more than 70% of Cambodians are still living on less than \$3 per day (ADB 2016). Cambodia's economy has already lower middle-income status (World Bank 2016). Employability rapidly fell in past 10 years in agriculture sector in Cambodia (Figure I.), the World Bank reported at 57.5% in 2007 and in 2017 already just 42.4% (World Bank 2018).

Figure I: Employment in agriculture (% of total employment)

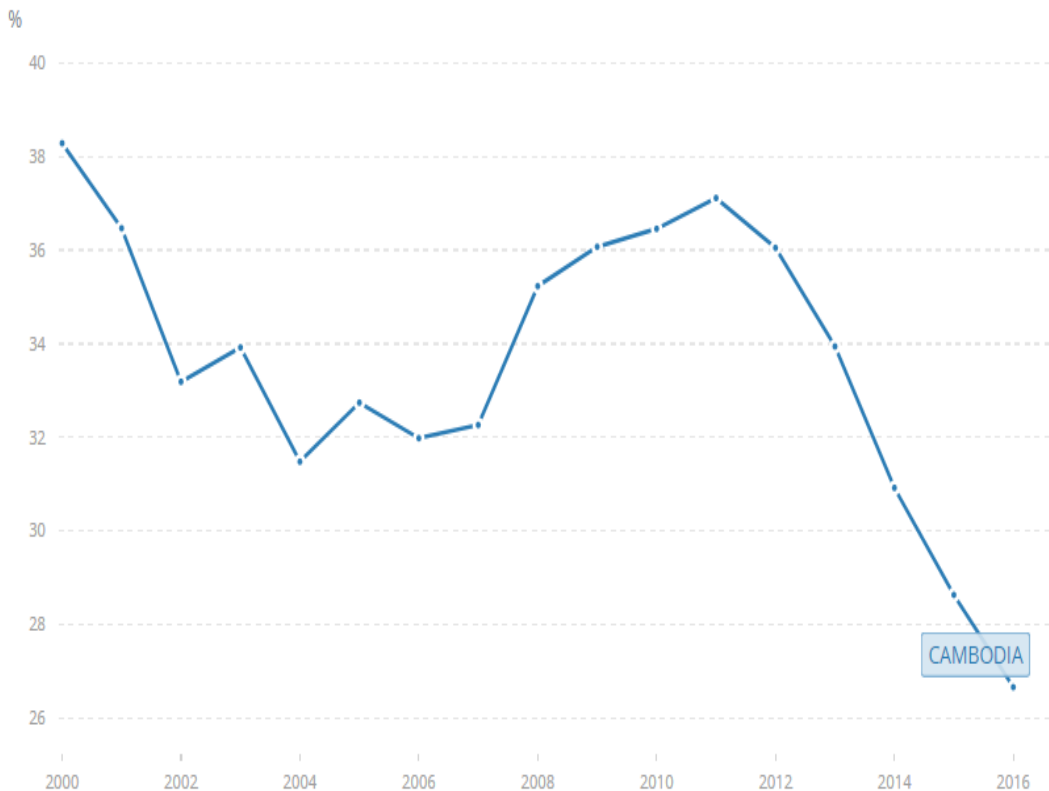


Source: World Bank 2018

The agriculture sector provides still the largest source of income, although the visible expand of industry and services. Investments have flowed in two last decades to the textiles, tourism, construction and agricultural sector. Industrial sector has more

significant growth even though agriculture still performance steadily improvement. GDP fell in agricultural sector from 37.11% in 2011 to 26.66% in 2016 as the World Bank reported (Figure II.) (IISD 2012).

Figure II: The share of agriculture in GDP



Source: World Bank 2018

According to OEC (The Observation of Economic Complexity) is Cambodia the 66th largest export economy in the world. Cambodia has negative trade balance, because in 2016 exported \$10B and imported \$11.7B. Even though the main commodities belong Knit Women’s Suits 17% (\$1.68B) or Leather Footwear 5.1% (\$507M) agricultural products are still playing important role in the Cambodian trade specially rice with 3.1% (\$306M). The top destination for exports is the United States (\$2.15B), the United Kingdom (\$953M) and Germany (\$903M). Main import countries are China (\$3.93B), Hong Kong (\$904M) and Singapore (\$771M) (OEC 2018).

2.3 Agricultural production

Cambodia's agricultural sector has been long dependent on vegetables imports from its bigger neighbours, but last years the government has set aside \$20 million to promote vegetables farming in Cambodia. Main problem of production vegetables and general agriculture sector is that Cambodians are thinking about that as a dependence on sustenance farming and not as opportunity for business. Secondly, farmers have a shortage of capacity building and relevant technological tools, and lastly are capital requirements. Cambodia needs around 10,000 professional farmers to plant vegetables and the government wants to support them with market access, warehousing, transporting services, as well as food-processing facilities. Currently, Cambodia requires 500 tonnes of vegetable a day, which costs around \$200,000 to \$300,000 a day. As these increases, the market will grow to \$200 million to \$300 million every year (Sarath 2015).

According to the Cambodia's Centre for Policy Studies (2017), the country imports anywhere between 200 to 400 tonnes of vegetables from neighbouring countries every day what means that local farmers are losing four-fifths of consumers, because exactly this amount took foreign vegetables. For ages rice was backbone of Cambodia's all-encompassing agricultural sector. However, with global rice prices falling and neighbouring countries such as Thailand and Vietnam are importing rice to the Cambodia, which the price is much lower that from local sources. Despite this, many smallholder farmers in Cambodia continue to rely on the cereal as the cornerstone of their crop production (Miller 2017).

The aquatic vegetables and fish produced by communities around Boeung Cheung Ek Lake in Phnom Penh are mostly sold fresh in marketplaces both inside and outside the city. Collectors transport these products to the marketplace where various traders are involved in buying and selling them. Aquatic vegetables account for nearly half of the total sales of vegetables in Phnom Penh (Khov et al. 2005).

The more affluent farmers in Kompong Thnaot grow peanut, sesame, watermelon, coconut, corn, and soya bean in addition to rice. In this way they protect themselves against seasonal food shortages as well as earn some extra income. Table I. provides in detail of main group of crop products which are in dry and wet seasons harvesting. The input cost to grow cash crops, peanuts for example, in a half-hectare plot is at least 24.4 USD (100,000 Cambodian riels), which includes expenses for fertiliser, seed, insecticide and irrigation. The harvest can be worth 48.8 USD (200,000 Cambodian riels) (Sedara et al. 2002). Total of agricultural products are \$346M and rice made 88%, cassava 6.1%, pepper 0.8%, guavas, mangoes and mangosteens 0.24% (OEC 2018).

Table I: Number of household activities by main group of crop production and season (2014 and 2015, in Thousands and Percent)

Main group of crop production	CSES 2014			CSES 2015		
	Total	Wet season	Dry season	Total	Wet season	Dry season
Number of activities						
Cereal harvested for grain	2,721	2,289	432	2,329	2,001	328
Tubers and leguminous plants	231	137	94	213	95	117
Industrial temporary crops	74	35	39	92	44	47
Vegetables	83	31	52	92	31	61
Fruits and nuts	308	154	154	318	159	158
Industrial permanent crops	124	64	60	170	87	83
Other crop not classified elsewhere	3	2	1	2	1	1
Total	3,544	2,713	832	3,215	2,419	796
Percent						
Cereal harvested for grain	72.6	74.1	65.8	72.4	82.7	41.2
Tubers and leguminous plants	5.8	5.8	6.0	6.6	3.9	14.7
Industrial temporary crops	4.0	3.3	7.2	2.8	1.8	5.9
Vegetables	4.7	3.3	11.1	2.9	1.3	7.6
Fruits and nuts	10.7	11.0	9.6	9.9	6.6	19.9
Industrial permanent crops	2.1	2.5	0.4	5.3	3.6	10.5
Other crop not classified elsewhere	0.1	0.1	0.0	0.1	0.0	0.1
Total	100	100	100	100	100	100

Source: Cambodia Socio-Economics Survey 2015

2.4 Consumers' preferences

Urban households are almost dependent on the market, more than 50% of rural households also rely on markets as their main source of food according to the Comprehensive Food Security and Vulnerability Analysis (WFP 2008). Rural households are less dependent on the food market, about 65% of food commodities are purchased in markets, because they are still able to produce food to feed their families, on the other hand, for urban households 93% is purchased. This indicates a high level of dependency on food markets for food consumption in both rural and urban areas (El-Noush 2010).

Food has a central position in the life of consumers. It is the source of nutrition and hedonic experiences, it serves a social and cultural function, and accounts for a major share of consumer expenditure (Steenkamp 1997). Evidence is from scientific researches that nowadays exist concerning the protective effect of fruit and vegetables against several diseases. Generally, it is recommended that an intake of 400g fruit and vegetables should be included in the daily diet to protect against disease (World Health Organization 1990). However, there are large variations in intake between regions, social classes and gender, and many differences exist between the highest and lowest consumers of fruit and vegetables (Pollard et al. 2002).

The theory of planned behaviour can explain and predict how behaviour is formed. There were formed three different processes of behaviour, behaviour attitude, subjective norms, and perceived behaviour control. The key idea is that if person first plans to do something then they are more likely to do it (Fishbein & Ajzen 2010).

2.5 Water pollution

Phnom Penh has a population of one and half million people and most of the urban domestic and industrial waste water drains to the Boeung Cheung Ek Lake/wetland. The sewerage and waste water treatment facilities to serve this population are seriously inadequate. The sewage networks, mostly built in the 1960s, are a combined sewage overflow from many sources including households, storm water, and industrial effluents (JICA 1999). There is no waste water treatment plant, so 10% of the effluents flow directly into the Mekong River without any treatment. The remaining 90% is loaded into retention basins that are the natural wetlands. Every day, about 55,600 m³ of household waste water and nearly 1 million m³ of storm water is discharged into three wetlands: Boeng Trabek, Boeng Tumpun and Boeng Cheung Ek (Muong 2004).

Cultivation of aquatic vegetables is an important activity that sustains the livelihoods of many families around lakes in Cambodia. The official functions of the Beung Cheung Ek wetlands are flood control and removal of pollutants from Phnom Penh city before the water eventually flows into the Mekong River. High metal concentrations were found in waste water sludge especially lead and mercury, which is as the untreated effluent of more than 3,000 industries drains into BC Ek Lake. A study done by the Ministry of the Environment of Cambodia estimated that 20% of the total daily vegetable consumption of Phnom Penh comes from BC Ek Lake and two smaller wetlands within the city (Muong 2004). Therefore, these waste water fed aquatic vegetables are, despite their potential health risks, very important in supplying the city's vegetable markets and thus meeting the demands of the growing population of Phnom Penh (Hoek et al. 2005).

Water convolvulus (*Ipomoea aquatica*) is the major crop grown in Beung Cheung Ek Lake. Large water surface areas near the villages are overgrown with Water morning glory and to a lesser extent with Water mimosa. Extensive human contact is high during the various production activities. Women and children living nearby often

harvest the plants and make bundles which are collected by middleman with a truck on a daily basis (Hoek et al. 2005).

Heavy metals contamination in aquatic environment is of critical concern, due to toxicity of metals and their accumulation in aquatic habitats. Trace metals in contrast to most pollutants, not bio-degradable, and they undergo a global ecological cycle in which natural water are the main pathways. Of the chemical pollutants, heavy metal being non-biodegradable, they can be concentrated along the food chain, producing their toxic effect at points after far removed from the source of pollution (Tilzer & Khondker 1993; Ahmad et al. 2010).

However, they may not be available for uptake by organisms in the sediment unless there is a direct route of entry through the skin surface or the gut. Although very low, the sediments are likely to continue for a long time at a slow steady rate. The toxic effect of such heavy metals, which are not utilized in the synthesis of new substances useful to the organisms, lies in their ability to be stored up in enzymes and displace chemically similar elements. In this way vital bio – chemical reactions are blocked. Such an accumulation of heavy metals can harm the organism itself or can be transmitted to the trophic level of the food chain, where a similar toxic process can take place (Karim 1994; Ahmad et al. 2010).

About two hundred households are living around Beung Cheung Ek Lake and are directly influenced from water pollution. It was found that these families have some of skin diseases. The diagnosis by the dermatologist showed that contact dermatitis (74%) was the most common skin disease, followed by superficial fungal infection (18%) and urticaria (9%). Skin problems and diseases mostly appeared on the hands (56%), feet (36%) and legs (34%) (Hoek et al. 2005).

The consumption of plants produced in contaminated areas, as well as ingestion or inhalation of contaminated particles two principal factors contributing to human exposure to metals (McBride 2003). It is known that serious systemic health

problems can develop as a result of excessive dietary accumulation of heavy metals such as cadmium, and lead in the human body. Although zinc and copper are essential elements, their excessive concentration in food and feed plants are of great concern because of their toxicity to humans and animals (Kabata-Pendias & Mukherjee 2007). Lead and cadmium are considered potential carcinogens and are associated with etiology of a number of diseases, especially cardiovascular, kidney, nervous system, blood as well as bone diseases (Järup 2003). Seriously health risks by consuming in long term period heavy metals consider also by Iyengar and Nair (2000) as well as by Türkdoğan et al. (2003). They mentioned that consumption of heavy metal-contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defences, intrauterine growth retardation, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates.

2.6 Characteristics of aquatic vegetables

The Ministry of the Environment of Cambodia reported that 20% of the total daily vegetables consumption of Phnom Penh is from aquatic vegetables from the waste water lake within the city (Hoek et al. 2005). Women and children, who are mainly harvesting vegetables, may get risk of skin problem such as hand and legs dermatitis, because of their extension contact with waste water (Hoek et al. 2005; Anh 2007).

Commercial production of aquatic vegetables in the city was first established prior to the country's civil war (pre - 1970), but expansions in production were hampered by poor market access. Aquatic vegetables, especially *Water convolvulus*, began to replace rice in Boeung Cheung Ek Lake using the city's increasing supply of sewage and as markets became re-established. Aquatic vegetables are now intensively cultivated throughout the year. Waste water provides most of the nutrients, but additional fertilisers and pesticides are also heavily applied (Khov et al. 2005).

Following vegetables are mainly offered at the local markets:

Water convolvulus – Ipomoea aquatica

Ipomoea aquatica belongs to the Class: Magnoliopsida; Order: Solanales; Family: Convolvulaceae; Sub class: Asteridae (Prasad et al. 2008). *Ipomoea aquatica* is a plant which is sort to aquatica or semi aquatica plants, which are trailing or floating, herbaceous, with long, hollow stem possessing of air passages and rooting at the nodes. Synder et al. (1981) was mention that flowers are infundibulum form long white or purple colour, leaves are elliptic or ovate-oblong (Anonumous 1959; Edie & Ho 1969; Gamble 1957).

Ipomoea aquatica can grow on moist soil, fresh water ponds, ditcher and wet rice fields or just even floating on water bodies. According to Wills et al. (1984) *Ipomoea aquatica* is one of the most popular green leafy vegetables with different English names as Chinese water spinach, kangkong, morning glory, swamp cabbage, water convolvulus or water spinach (Anonymous 1959). Origin of *Ipomoea aquatica* is in China (Edie & Ho 1969). Distribution is already around the world throughout tropical Asia, Africa and Australia (Kirtikar & Basu 1952).

The leaves contain moisture 90%, protein 3%, fibre 0.9%, fat 0.4%, carbohydrate 4.3%, mineral matter 2% (Anonymous 1959). *Ipomoea aquatica* which are eaten raw are rich in proteins what proved Ngamseang et al. (2004), minerals as sodium, calcium, iron, magnesium, organic acids, carotenes (Chen & Chen 1992; Duc et al. 1999).

Water dropwort – Oenanthe javanica

Oenanthe is a taxonomically complex genus due to its diverse morphology and widespread dispersal. About 30 species are included to the genus *Oenanthe* L. ("water dropwort", Apiaceae), they are distributed in Asia, North America and

Africa. *Oenanthe javanica* is using in East Asia as vegetables and as traditional medicines (Kwon et al. 2006).

It is well known as the treatment of hypertension, jaundice and polydipsia (Ji et al. 1990). *Oenanthe javanica* has different pharmacological and biological activities such as anti-inflammatory, antioxidant and anti-hepatitis B virus activities (Kim et al. 2013; Kwon et al. 2006; Han et al. 2008). The most widely species is *Oenanthe javanica*, which has been cultivated and use the most in Southeast Asia, China, Japan and Korea. Fresh leaves have high levels of proteins, amino acids, iron, Vitamin C, calcium and flavonoids. Water dropwort (*Oenanthe javanica*) is economically important plant which grows also wildly in freshwater marshes and swampy fields, ditches, canals and streams (Zhou & Wang 2010).

Water mimosa – *Neptunia oleracea*

Neptunia oleracea belongs to family of Mimosaceae. This plant is known as a water sensitive plant, growing usually in lakes, ponds and drains. Bipinnate leaves are sensitive to touch and to fluctuations in light. Stems of Water mimosa are spongy, and they are providing buoyancy on water surface. It has ability to fixate nitrogen through root nodules on submerged roots. This species can reproduce via stem fragments which produce root at their joints, but this plant grows also from seeds (Suppadit 2008).

According to study from Veschasit et al. (2012) it was found that Water mimosa is able to remove soluble solid, reduce biological and chemical oxygen demand efficiently. It can accumulate heavy metals such as copper (Cu), lead (Pb), zinc (Zn) and cadmium (Cd). That ability to accumulate heavy metals is not only one because Water mimosa is able to capabilities to treat waste in black tiger shrimp farms (Suppadit et al. 2005).

Water mimosa is using in Southeast Asia countries as food and medicinal plant because has a good source of calcium, vitamin C, A, and niacin all these elements

are important for metabolism of nutrient in the human body specially for energy generation. Beta-carotene and phosphorus are also consisting in fibres of Water mimosa. Wang was reported in 2008 and later Fernando 2011 confirmed that Water mimosa is usually collected and cultivated for young shoots and usually eaten raw, cooked or fried.

Fish mint - *Houttuynia cordata*

Saururaceae is a member of paleoherbs and an ancient family with six species in four genera, *i.e.*, *Anemopsis*, *Gymnotheca*, *Houttuynia* (Liang 1995). Only one species in the genus *Houttuynia* is *Houttuynia cordata* (Fang 1981). *Houttuynia cordata* propagate by formation and separation of underground stems and by pathogenesis even though Hayashi reported that sexual reproduction has not been determined yet (Mihara 1960; Hayashi et al. 1995).

Fish mint is mainly distributed in China and extends to almost whole Southeast Asia, where is growing in shady and moist places. *Houttuynia cordata* belongs to traditional Chinese medical herb, because of unique quality to improve the immune system of patients which have severe acute respiratory syndrome (Lu et al. 2006). The steam, which is distillate from fresh plants, inhibits herpes virus type 1, influenza virus and human immunodeficiency virus 1 (Hayashi et al. 1995). *Houttuynia cordata* is consumed as vegetable for special aroma, although this plant has high medicinal and economic value, wild *Houttuynia cordata* population resources are limited, what is also limitation for the breeding of new cultivated varieties (Wei & Wu 2012).

Cambodian mint – *Polygonum odoratum*

Polygonum odoratum is known as Vietnamese coriander or Cambodian mint although is not related to mints not even to mint family. *Polygonum odoratum* grows in tropical and subtropical zones, cultivated widely in Vietnam and belongs

to *Asparagaceae* (Ravindran 2017). Cambodian mint is short-lived plant, fragrant herbs. The stem is approximately 30-35 cm tall, leaves are alternate, short. Flowers are hermaphrodite, bisexual, white to purplish-pink (Spencer 1997; Ravindran 2017).

Cambodian mint is used in folk medicines of the regions of growing. The leaves have many different applications as a diuretic, febrifuge, stomachic and anti-aphrodisiac, but also crushed leaves are applied against fever, ringworm and vomiting. Juice from leaves can be helpful against snakebites with covering residue of the leaves. Cambodian mint is often using for traditional dishes in Southeast Asia. Flavour is combination of lemon, mint and coriander (Prasad et al. 2008).

2.7 Consumption of vegetables

In food consumption, there has been a significant transition from staple foods such as rice and wheat to high-value products such as meats, aquatic products, vegetable oils and dairy products (Zhang et al. 2003). The Water Convolvulus (*Ipomoea aquatica*) is the most common species grown in the wetland of Boeng Cheung Ek (Muong 2004).

Aquatic food products flow from producer to consumer through middlemen or the wholesalers. Sometimes the producers themselves are the wholesalers as they transport their product by motorbike directly to the markets in the city. The middlemen increasingly use small trucks for transportation from farm to market. Retailers from the provinces come to the markets in the city to take fish and aquatic vegetables back to the provinces. A large proportion of producers also take credit from private lenders at high rates of interest. The price is highest in the dry season from December to July, because of low water levels and hence poor water quality in the lake. As a result, the overall quality of aquatic vegetables also decreases (Khov et al. 2005).

Table II: Vegetables varieties and daily consumption in Phnom Penh

English name	Scientific name		Farmers involved	Surface (m ²)	Production (kg/day)	Price USD/kg
	Species	Family				
Water convolvulus	<i>Ipomoea aquatica</i>	<i>Convolvulaceae</i>	248	1.086.116	21.787	0.03
Peppermint	<i>Mentha arvensis</i>	<i>Labiatae</i>	18	29.803	660	0.10
Cresson	<i>Oldenlandia fraterna</i>	<i>Cruciferae</i>	21	25.175	1.167	0.38
Leaf lettuce	<i>Letuca sativa</i>	<i>Compositacea</i>	17	23.452	655	0.77
Chinese kale	<i>Brassica juncea</i>	<i>Cruciferae</i>	13	21.010	498	0.26
Mustard green	<i>Brassica oleracea</i>	<i>Cruciferae</i>	8	19.397	210	0.21
Lotus	<i>Nelumbo nucifora</i>	<i>Nymphaeaceae</i>	4	7.000	390	0.03
Chili pepper	<i>Caspicum annum</i>	<i>Solanaceae</i>	2	4.600	23	0.21
Amaranth	<i>Amaranthus tricolor</i>	<i>Amarantaceae</i>	7	4.240	230	0.17
Water mimosa	<i>Neptunia Oleracea</i>	<i>Convolvulaceae</i>	2	3.300	70	0.38
Yard-long bean	<i>Vigna unguiculata</i>	<i>Leguminocae</i>	2	3.000	60	0.21
Angled luffa	<i>Luffa acutangula</i>	<i>Cucurbitaceae</i>	5	1.776	83	0.06
Total			294	1.228.869	25.359	

Source: Muong 2004

2.8 Dietary habits

In Cambodia, the energy and nutrient densities of the traditional rice-based complementary diets used for infant feeding are very low. Whether the adequacy improves after the first year of life is uncertain (Anderson et al. 2008). Rich in biodiversity, Cambodia's rice field ecosystems are an important source of livelihood and food security. Foraging of aquatic plants and animals alongside the cultivation of rice has been the main characteristic of food and income systems of traditional Cambodian rural society. Unsustainable interventions for economic development

and modernization (such as increased use of agro-chemicals, development of irrigation, and drainage structures) may reduce the productivity of rice field ecosystems and affect livelihood patterns and food security. Small fish made up 50–80% of all fish eaten during the fish production season in rural Cambodia (Shams 2005).

Dietary habits appear to basically the same among the Khmer and other ethnic groups, although the Muslim Cham do not eat pork. The basic food is rice which is using in several varieties, vegetables, especially water convolvulus and fishes. The average rice consumption per person per day before 1970 was almost one-half kilogram. Fermented fish which are in form of sauce or paste are important source of protein in Cambodians diet. Khmer are using as flavour hot peppers, lemon grass, mint and ginger but sugar is added to many foods. The basic diet is supplemented by vegetables and fruits as bananas, mangoes, papayas, rambutan, and palm fruit – both wild and cultivated, which grow abundantly throughout the country. Poultry, beef, pork and eggs are added to meals on special occasions or if family can afford it (World Food Programme 2010; Hays 2008).

3. Aims of the Thesis

The main objective of the study is to analyse - the consumers' attitudes to aquatic vegetables in area of the capital city Phnom Penh in Cambodia. Specifically, the study seeks to answer the following objectives:

1. To identify the most consumed aquatic vegetables by Cambodian consumers,
2. To determine consumers' attitude to aquatic vegetables in relation to socio-demographic characteristics of respondents (gender, age, education, occupation, residence, marital status, members in household, members in household in productive age),
3. To evaluate awareness of consumers regarding health consequences.

3.1 Research Questions

Vegetables are the usual diet of locals and problematic grow in waste water can negatively influence health of farmers and consumers and relate to their socio-demographic factors. The research questions have been designed for finding the answer related to the impact of waste water and quality of aquatic vegetables related to health of farmers and consumers and willingness to buy locally produced vegetables and factors which are influencing consumption in Phnom Penh:

1. Which are the most preferred aquatic vegetables by Cambodian consumers?
2. Do socio-demographic factors influence the consumption of aquatic vegetables?
3. Do Cambodian consumers take aquatic vegetables as health-conscious?

3.2 Research Hypothesis

1. Null Hypothesis H_0 : The most preferable aquatic vegetable is Water convolvulus (*Ipomoea aquatica*).
2. Null Hypothesis H_0 : Aquatic vegetables are taken as health conscious.

4. Materials and Methods

4.1 Research Design

Primary quantitative data were collected through a questionnaire-based survey. Fieldwork was done from middle of August until middle of September 2018 in the capital city Phnom Penh. The recruitment of participants was based on the personal judgement of the researcher, taking the predetermined quota and respondent's willingness to participate into account.

The main goal of the research study was to get relevant information about consumers' attitudes to aquatic vegetables with comparison of socio-demographic characteristics of respondents in the capital city Phnom Penh in Cambodia. The specific objectives have been designed for evaluation consumption and usage of aquatic vegetables. Awareness of consumers regarding to health problems was included to closer specify how consumers thinking about problems of waste water and wetlands where are grown vegetables. Based on this was chosen sampling size 384 by calculation with 95% convenience level and marginal error 5% calculated with number of inhabitants from Phnom Penh (1,502,000). Respondents were specifying as citizen of the capital city in productive age (15-65). As method for sampling was selected convenience sampling method with snowball sampling method which can be use thank distribution from local consumers. Source of data collection, which were used, include primary and secondary data.

Table III: Chosen species of aquatic vegetables in English, Latin, Khmer language and used abbreviation

English name	Latin name	Khmer name	Abbreviation
Water convolvulus	<i>Ipomoea aquatica</i>	ត្រកួន	WC
Water dropwort	<i>Oenanthe javanica</i>	ក្លោកង្កែប	WD
Water mimosa	<i>Neptunia oleracea</i>	កញ្ជ្រាត	WM
Fish mint	<i>Houttuynia cordata</i>	ឆ្កាប	FM
Cambodian mint	<i>Polygonum odoratum</i>	ក្រសាំងទំហំ	CM

4.2 Study area

The city of Phnom Penh was selected as study area of the research due to the biggest concentration of consumers as well as the highest production of aquatic vegetables. In the capital city, daily production of these vegetables is around 160 tonnes and consumption are much higher because of high import of these products from neighbouring countries as Vietnam and China. Production is focused mainly in area of lakes: Boeng Tmat and Boeng Tompun. Around three million of local people are influenced directly from these lakes with the problematic issue as waste water. Up to 80% of Phnom Penh’s waste water is pumped into the lakes, as well as industrial and chemical effluents from a growing industrial sector, which is also located around the lakes (Khov 2005). Due to these facts, the objectives of study were considered to support awareness of consumers regarding health risks of consuming aquatic vegetables.

4.3 Data collection

Primary and secondary data were used for the research. The primary data were collected through a questionnaire-based survey from local consumers from mid-August till mid-September 2018. The study was based on quantitative tools to collect primary data through structured questionnaire.

Secondary data is part of the research in which scientific articles and journals which are mainly from a Web of Science, Google Scholar, Scopus and Science Direct for discussion and comparison the results of this study. Relevant sources were also used as official documents from government and from other relevant institutions.

4.4 Sampling strategy

The number of habitants in capital city of Cambodia Phnom Penh is 1,502,000. The study targeted consumers of aquatic vegetables in the capital city Phnom Penh that is why was selected convenience sampling method because the sample is taken from a group of people easy to contact or to reach. This method was selected for any other criteria except that consumers were available and willing to participate. The snowball sampling method was also integrated through locals which were more trustworthy for target group.

4.5 Questionnaire design

The questionnaire included closed-ended questions in form of fixed measurement scales using metric interval Likert (Liker 1932) and semantic differential scales (Osgood et al. 1957). The questionnaire consisted three parts. Consumers' attitudes were measured by combining two subjective assessments related to consumption and use of aquatic vegetables, with an objective assessment of awareness of consumers regarding to health conscious and last part socio-demographic characteristics of respondents (Pollard et al. 2002; van Kleef et al. 2005). First, general consumers attitude and consumption of aquatic vegetables were evaluated by a five-point Likert scale and closed-ended questions with multiple options. Second, "beliefs" of consumers about health conscious were assessed by evaluating by semantic differential scales. Last part included socio-demographic characteristics, which were measured by closed-

ended questions based on structure of households (age, gender, place of origin, level of education etc.).

4.6 Data analysis

The questionnaire was pre-tested and modified before starting the fieldwork. After editing and codification, the data were analysed by statistic methods in Minitab statistical software.

The data were processed in MS Excel and descriptive statistics was used for a basic feature of the study results. The data analysis including mean, percentage and multiple responses tools were used for summarization information on socio-demographic characteristics of the respondents. To determine the association between consumer preferences, availability of aquatic vegetables on the market and health conscious of aquatic vegetables and independent variables (gender, age, education level, occupation, residence and household structure) was chosen Pearson Chi-squared test. This test was also used to evaluate a statistical significance with p-values set at 0.05.

5. Results

A total of 393 questionnaires were completed and valid for further analysis. Characteristics of sample are presented in Table IV. providing overall gender and age distribution. The results indicated that gender distribution was not balanced, and percentage of female responses was higher by 18%. The majority of respondents were in the age groups < 25 and 26 – 40 (66%).

Table IV: Sample characteristics (n=393): age and gender distribution (%)

	Male (n=162)	Female (n=231)	Total (n=393)
<i>Age groups</i>			
<25	31	35	33
26–40	34	32	33
41–50	18	14	16
>51	17	19	19
<i>Gender distribution</i>	41	59	100

Socio-demographic characteristics in the survey included questions about occupation, residence and education, which are presented in detail in Table V. The data were collected in the capital city Phnom Penh which is demonstrated by high percentage of respondents from urban area, however almost one third reported rural area as their residence. Occupation of respondents was one part of the questionnaire and the most common answer was services. Regarding to quite high percentage of respondents living in rural area agriculture as a livelihood marked almost same percentage as respondents working in business-economy area. With respect to education almost half respondents finished secondary school level with comparison with high school level it is the lowest percentage. Nevertheless, still almost 10% of respondents reported any reached education level. The detail analysis of results showed that 62% respondents were married, and average family had three to six members, what represents 76%.

Table V: Sample characteristics (n=393): occupation, residence and education (%)

<i>Occupation</i>	Agriculture 24	Business-economy 27	Student 12	Services 31	Industry 6
<i>Residence</i>	Rural area 31	Sub-urban area 7	Urban area 62		
<i>Education</i>	Primary school 26	Secondary school 40	High school 4	University 23	None 7

The Pearson Chi-squared test was used to determine the association between socio-demographic characteristics as gender, age, level of education, occupation etc. and detail consumption of aquatic vegetables. P-value was considered <0.05 to be statistically significant. Table VI. shows the association of individual socio-demographic characteristics with detail consumption of aquatic vegetables. For some of characteristics was found out that p-value is <0.05 and in this case the hypothesis H1, characteristics as gender, age, education level, occupation, residence, marital status, members in household and members in household in productive age directly influence consumption of aquatic vegetables was confirmed.

Table VI: Association between socio-demographic characteristics and consumption of vegetables

	Total sample		Water convolvulus				Water dropwort				Water mimosa				Fish mint				Cambodian mint			
	N	%	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)
Gender/p-value			0.292	0.140	0.812	0.059	0.422	0.399	0.909	0.210	0.629	0.492	0.900	0.039	0.378	0.586	0.914	0.108	0.989	0.860	0.715	0.175
Male	164	42	35	57	7	1	70	23	6	1	58	33	8	1	65	24	5	6	62	27	6	5
Female	229	58	41	50	6	3	73	20	5	2	55	34	7	4	60	26	5	9	60	26	5	9
Age/p-value			0.035	0.623	0.001	0.834	0.243	0.116	0.069	0.074	0.891	0.471	0.087	0.941	0.005	<0.001	0.364	0.041	0.965	0.717	0.018	0.023
<25	129	33	29	54	13	4	71	19	8	2	59	29	10	2	67	22	7	4	59	29	10	2
26-40	129	33	40	55	4	1	78	17	4	1	54	38	4	4	69	22	3	6	59	28	4	9
41-50	61	15	44	54	0	2	64	31	3	2	57	31	11	1	46	39	7	8	61	28	7	4
51>	74	19	47	46	4	3	69	24	3	4	55	36	6	3	54	26	5	15	62	22	0	16
Occupation/p-value			0.064	0.059	0.171	0.360	0.065	0.008	0.110	0.231	0.034	0.003	0.013	0.023	<0.001	0.002	0.162	0.007	0.024	0.041	0.577	0.092
Agriculture	95	24	34	53	8	5	66	23	5	6	51	31	11	7	47	27	10	16	56	23	7	14
Business-economy	106	27	49	46	3	2	77	15	7	1	64	28	5	3	75	16	2	7	68	21	4	7
Student	48	12	35	50	15	0	79	10	11	0	65	21	14	0	77	15	8	2	71	21	8	0
Services	120	31	33	60	6	1	66	30	3	1	48	46	4	2	53	37	6	4	50	38	6	6
Industry	24	6	50	42	4	4	87	13	0	0	71	29	0	0	71	25	0	4	67	25	4	4
Residence/p-value			0.184	0.895	0.532	0.402	0.126	0.136	0.874	0.401	0.003	0.006	0.526	0.022	0.008	0.027	0.458	0.291	0.362	0.259	0.547	0.386
Rural area	121	31	34	52	8	6	67	22	6	5	45	43	6	6	51	34	8	7	55	32	7	6
Sub-urban area	28	7	29	62	5	4	65	31	4	0	46	50	4	0	75	18	7	0	61	29	6	4
Urban area	243	62	41	53	6	0	75	20	5	0	63	28	8	1	66	21	5	8	63	24	4	9
Education/p-value			0.395	0.276	0.129	0.201	0.056	0.010	0.064	0.107	0.303	<0.001	0.012	0.043	0.273	0.028	0.014	0.073	0.334	0.489	0.102	0.001
Primary school	102	26	45	50	2	3	79	16	3	2	55	38	4	3	59	33	4	4	65	28	2	5
Secondary school	155	40	37	58	3	2	66	30	3	1	53	39	6	2	62	23	6	9	54	30	6	10
High school	15	4	33	67	0	0	93	7	0	0	53	47	0	0	53	47	0	0	67	26	7	0
University	92	23	32	47	20	1	73	14	12	1	66	18	15	1	71	17	9	3	64	25	9	2
None	29	7	45	45	0	10	66	27	0	7	52	35	3	10	55	21	3	21	59	14	3	24

	Total sample		Water convolvulus				Water dropwort				Water mimosa				Fish mint				Cambodian mint			
	N	%	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)	<1day (%)	2-4days (%)	5-6days (%)	daily (%)
Marital status			0.467	0.606	0.406	0.297	0.626	0.068	0.098	0.218	0.160	0.279	0.306	0.081	0.268	0.577	0.650	0.430	0.259	0.327	0.208	0.464
Single	132	34	33	55	12	0	74	18	7	1	64	28	9	0	68	22	7	3	62	27	7	4
Married	244	62	41	53	3	3	71	23	4	2	52	38	6	4	59	27	5	9	59	27	5	9
Divorced	10	2	50	50	0	0	60	30	10	0	50	30	20	0	50	20	10	20	40	40	0	20
Widow/Widower	7	2	43	29	0	0	86	0	0	0	71	14	0	0	71	14	0	0	86	0	0	0
Members in HH			0.993	0.734	0.201	0.533	0.497	0.696	0.147	0.168	0.457	0.736	0.893	0.326	0.775	0.936	0.741	0.501	0.459	0.943	0.788	0.544
1 - 2	41	10	39	54	7	0	68	22	7	3	59	34	7	0	59	29	7	5	54	29	7	10
3 - 4	174	44	39	56	3	2	73	23	3	1	55	36	7	3	64	24	4	8	62	27	5	6
5 - 6	120	31	38	49	9	4	69	19	8	4	53	34	8	3	59	25	6	9	56	27	7	10
7+	58	15	38	53	9	0	79	17	2	0	66	28	5	0	64	24	7	3	66	24	3	5
Members productive age			0.672	0.123	0.062	0.097	0.709	0.239	0.621	0.268	0.545	0.344	0.722	0.270	0.735	0.537	0.800	0.932	0.896	0.436	0.593	0.499
1 - 2	223	57	38	57	4	1	70	24	5	1	56	35	7	2	62	27	4	7	58	30	6	6
3 - 4	115	29	36	46	11	4	73	18	5	2	57	31	8	4	63	22	6	7	63	23	6	7
5 - 6	37	9	46	43	5	3	78	11	5	3	65	27	3	3	54	30	5	8	59	22	3	14
7+	18	5	44	56	0	0	78	22	0	0	44	50	6	0	67	17	5	11	61	28	0	11

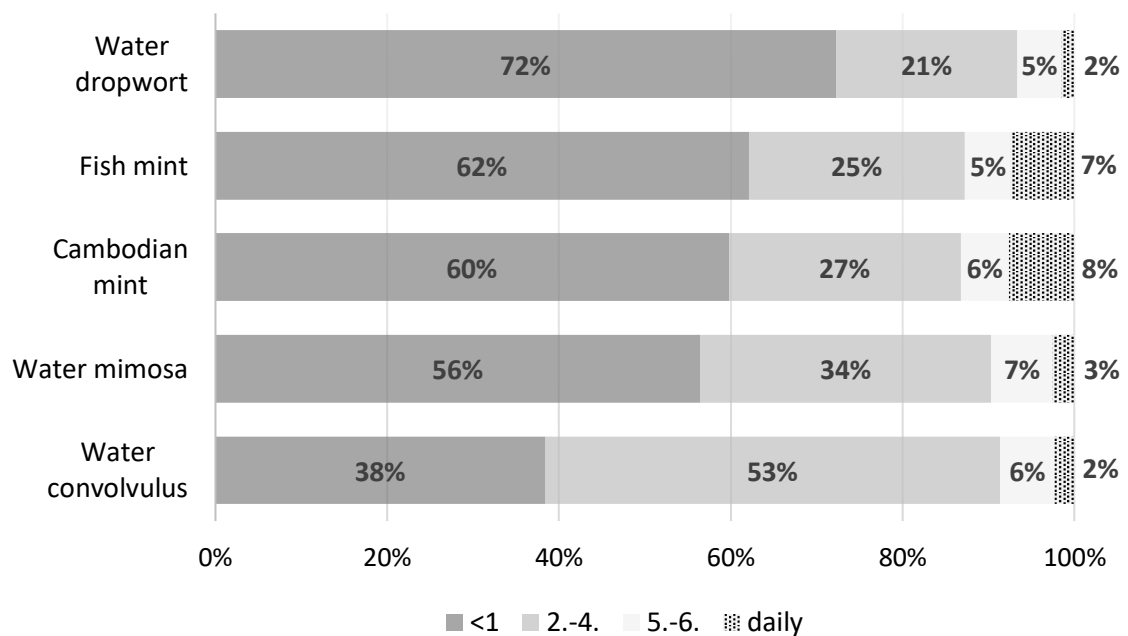
The Pearson Chi-squared test was used as well to analyse opinions of respondents regarding to food security of aquatic vegetables. In questionnaire were used three questions, which were focused on access on local market and quality of products and if respondents considered aquatic vegetables as healthy beneficial. All three questions were statistically analysed if opinions could influence consumption of aquatic vegetables. According to analysis in Table VII. it is clearly visible that all three-assessment effect consumption of at least in three from five aquatic vegetables.

Table VII: Association between opinion of food security and consumption of aquatic vegetables

Food security	Water convolvulus	Water dropwort	Water mimosa	Fish mint	Cambodian mint
Aquatic vegetables are easily accessible in the local market.	0.003	0.013	0.002	0.155	0.104
Quality of aquatic vegetables on local market is good.	0.532	0.320	0.022	0.018	0.055
Aquatic vegetables are beneficial for your health.	0.280	0.013	0.041	0.005	0.451

The four scale of measurement of consumption was formed how often are consumers buying aquatic vegetables per week from the less and one day per week to daily. Consumption scale and five types of aquatic vegetables common in Cambodia are presented in Figure III. The most preferable aquatic vegetable is Water convolvulus (*Ipomoea aquatica*) in which the majority of respondents reported that are buying from two to four days per week. Other four vegetables were determined less used because in all of them more than half respondents marked choice one or less days per week in case of Water dropwort it was even 72% of respondents. Moreover, interesting fact is that Cambodian mint is the most preferable aquatic vegetable consumed daily.

Figure III: Consumption of aquatic vegetables



The detail analysis showed that comparison of particular socio-demographic characteristics and consumption of individual aquatic vegetables is well-marked in case of daily consumption. Because all types of aquatic vegetables, which were analysed within the scope of this research, are consumed in Cambodia very often and by all respondents, the significant differences were found in daily consumption.

That is reason why detailed analysis is focused on daily consumption of respondents.

The preferences of five variables of aquatic vegetables with comparison of gender is in detail provided in Figure IV. Female’s daily consumption is clearly higher in all types of vegetables. According to the detail analyses the most visible differences are between male and female consumption in case of Fish mint and Cambodian mint and in the same time daily consumption of these vegetables are the highest. Interestingly other three vegetables are consumed by male rarely even though female’s daily consumption is largely higher.

Figure IV: Daily consumption of aquatic vegetables in comparison with gender of respondents

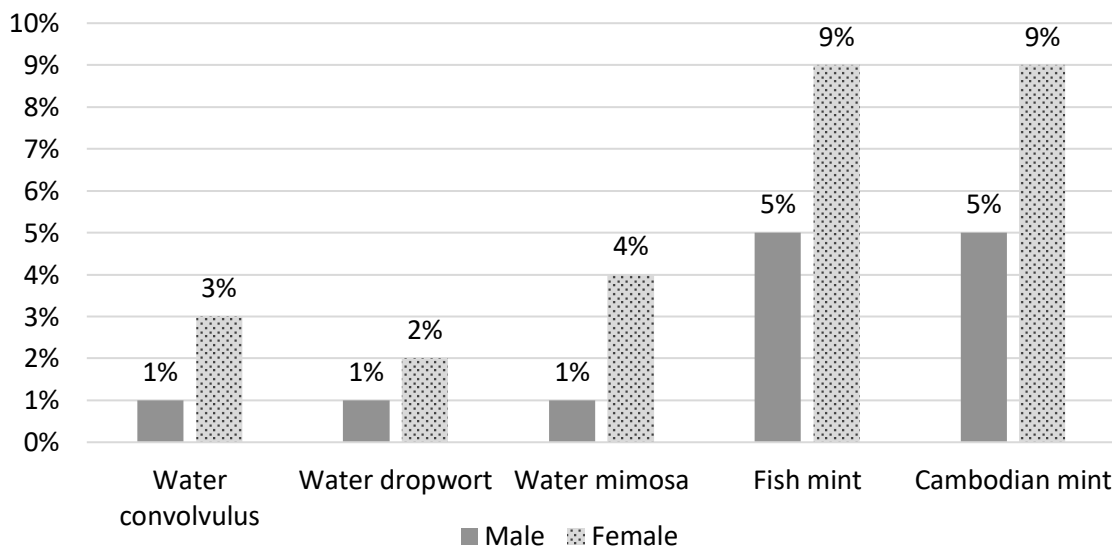
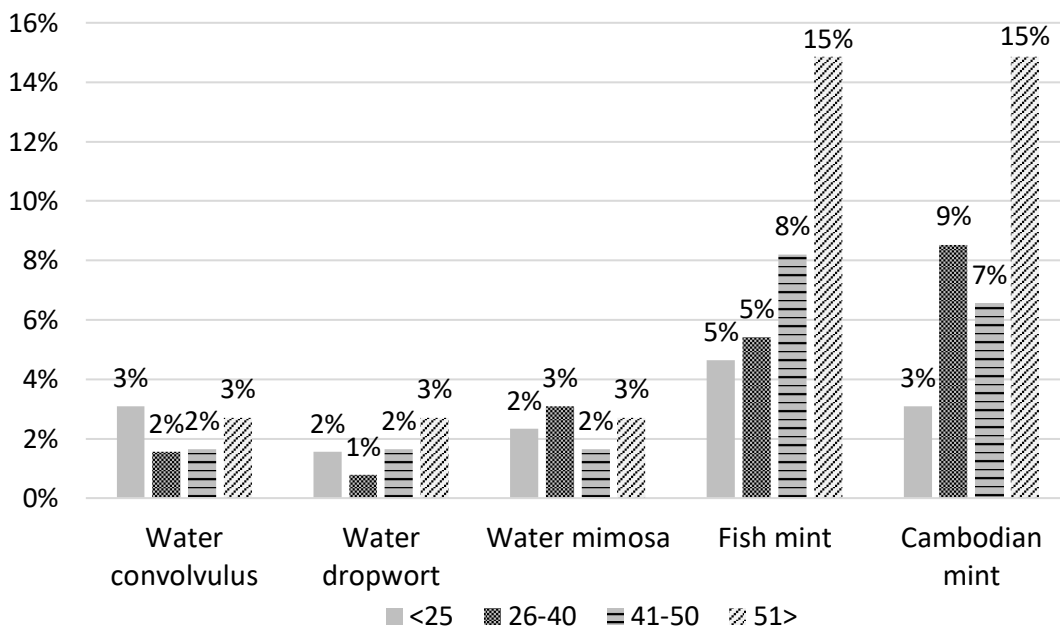


Figure V. shows daily consumption with differences between age groups and specific aquatic vegetables. The highest deflections are visible in case of two aquatic vegetables – Fish mint and Cambodian mint. Both types of vegetables have highest number of respondents which consumed them every day. On the other hand, they have also the most visible disparity between individual age groups. In case of Fish mint two age groups (<25, 26–40) have equal percentage and the most significant daily consumption was reached by group in age plus 51. Almost same numbers have

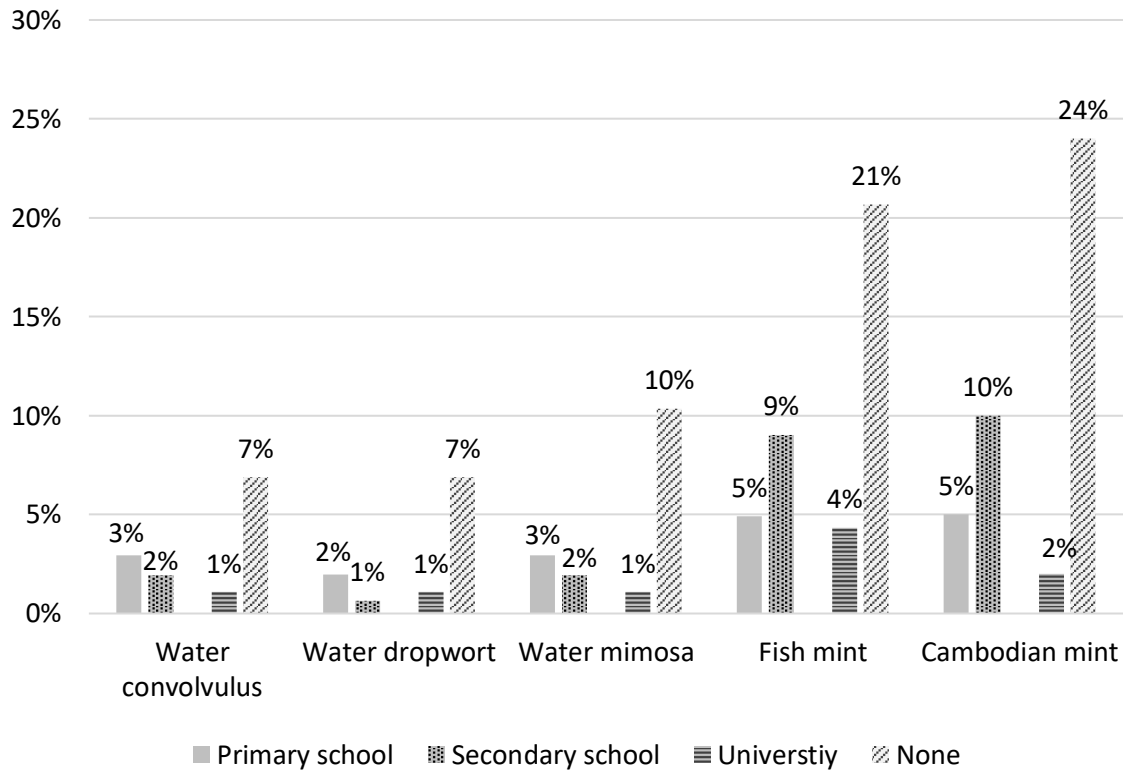
also Cambodian mint, which starts in 3% of youngest age group, growing to 9% for age from 26 to 40 and then again, the age group up 51 years old respondents have highest percentage. In detail comparison of daily consumption relevant for three species of aquatic vegetables (Water convolvulus, Water dropwort, Water mimosa) are not visible any significant differences between individual age groups.

Figure V: Daily consumption of aquatic vegetables in comparison with age of respondents



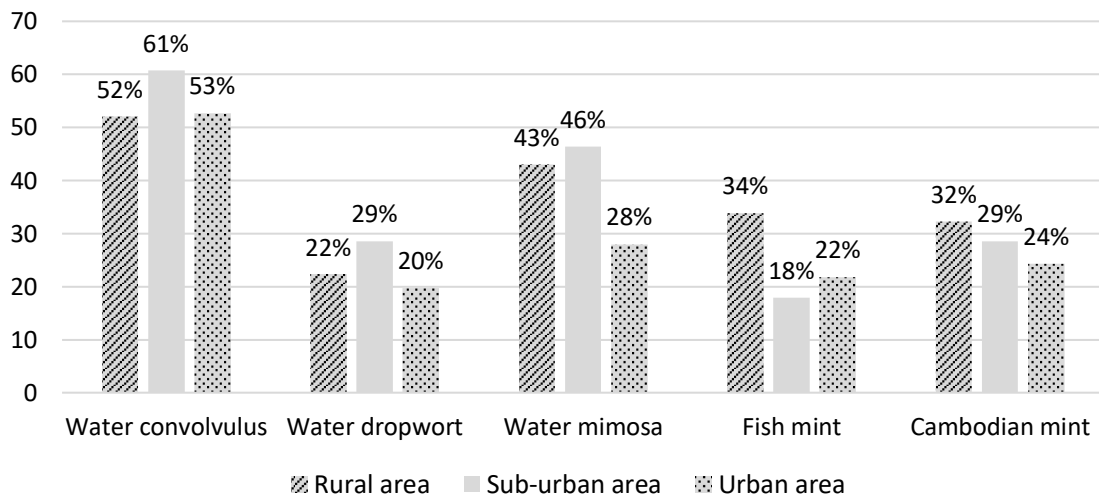
With respect to the education Figure VI. shows daily consumption of aquatic vegetables with comparison to education level. The detailed analysis of results showed that there was a significant difference among education level. And interesting fact was found that the respondents who marked none reached education level have the highest daily consumption. The most noticeable differences were found in consumption of Cambodian mint from the lowest 2% to the highest from all variables 24%.

Figure VI: Daily consumption of aquatic vegetables in comparison with education level



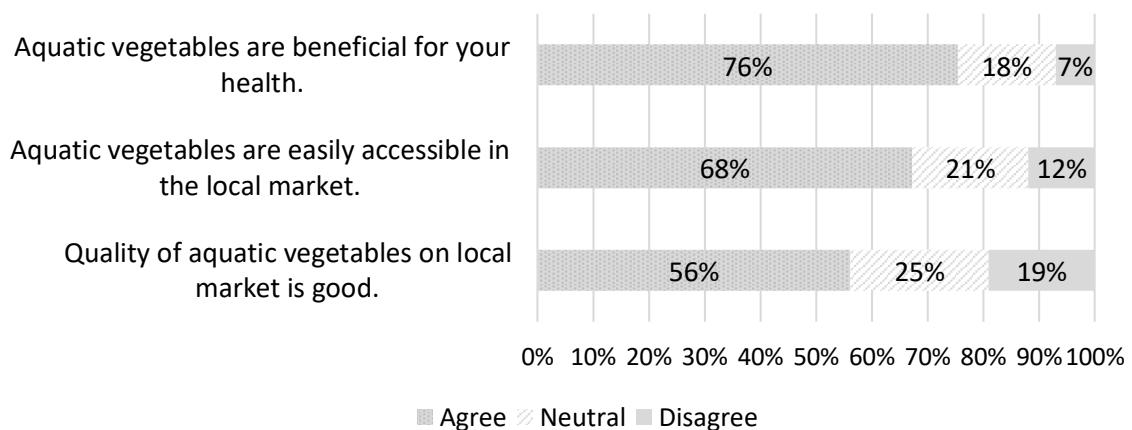
The survey included question regarding to residence of respondents. Even though that research study area was located in the capital city Phnom Penh, in results of consumption from two to four days of aquatic vegetables in Figure VII. were found that in all species of vegetables respondents stated that their residence was also in rural and sub-urban area. Interestingly in sub-urban area are three aquatic vegetables consumed more than in urban and rural area. Further analysis consumers attitudes were conducted to examine where is consumer’s residence. In the detail analyses was found that Water convolvulus is consumed much more in than other types of aquatic vegetables.

Figure VII: Consumption 2-4days per week of aquatic vegetables in comparison of respondent's residence



Part of the research was food security in case of aquatic vegetables and awareness respondents to the problematic issue with cultivation aquatic vegetables in wet lands contaminated by waste water from the city. Figure VIII. shows three questions which were focused on the opinion of respondents to the quality, health conscious of aquatic vegetables and access in the market. Interestingly is that almost 80% of respondents agreed that aquatic vegetables are beneficial for their health however 19% of respondents reported that quality of aquatic vegetables in the market is not good.

Figure VIII: Opinion of respondents to the quality, health conscious and access in the market of aquatic vegetables



6. Discussion

Our study was focused on consumption of aquatic vegetables in Cambodia which are one of the most common sources of food. In the study area was found the problematic issue of their growing in wetlands in the capital city which are high polluted. This topic was mentioned as well in the research guaranteed by Economy & Environment Program for South East Asia (EEPSEA) done by Muong (2004).

In many countries of South East Asia, it is the most common aquatic vegetable Water convolvulus (*Ipomoea aquatica*) and moreover specially in China and Vietnam is consumption much higher than in other countries also because medical usage of this plant. This fact was proved in Muong's (2004) research which was specify for Cambodia and especially in Boeng Cheung Ek is the most common species. According to a field survey done by the Muong in 2002, 249 farmers who produced up to 26 tons per day of edible vegetables on 123 ha of farmland located in the three biggest wetlands (Boeng Tumpun, Boeng Trabek, Boeng Cheung Ek). Boeng Trabek is located almost in the urban centre of Phnom Penh with surface area from 35 ha in the dry season to 40 ha in the wet season (Muong 2002). Production of vegetables in these three wetlands were in interest of research from Khov (2005). The area around this lake is known for high amount of production aquatic vegetables especially Water convolvulus (*Ipomoea aquatica*) and Water mimosa (*Neptunia oleracea*). According to survey done by Muong in 2004 was proved that Water convolvulus is most produced plant variables in Phnom Penh in detail it is around 21,700 kg per day. As it was already mentioned Water mimosa is second most common from aquatic vegetables. Amount of prediction is still much lower than in case of Water convolvulus around 70 kg per day (Muong 2004). Based on our analysis results from questionnaire survey from the capital city Phnom Penh it is clearly proved that the most consumed species of aquatic vegetables are Water convolvulus and Water mimosa. More than 50% of respondents consume Water convolvulus from two to four days per week and in same days period is consume Water mimosa by 34% of respondents. These vegetables are basic ingrediency for most of the Cambodian

typical meals. Results from our questionnaire confirmed consumption of individual vegetables which was found in science articles, especially in case of Water convolvulus was clearly visible correlation between our results from survey in the capital city and from articles relevant to this topic. Water convolvulus is high cultivated in neighbouring countries and export of this product is in large amount to the local markets what could influence consumption because of better availability of specific aquatic vegetable.

Consumers attitudes influence directly some of the demographic and socio-demographic factors such as gender, age, education level and economic status (Wilcock et al. 2004). Household consumption depends on different factors where are counted also socio-demographic characteristics and household consumption is the consumption of goods by households, what includes the selection of goods, purchase, use, product of services etc. (Sennes et al. 2015). In household structure it is important for consumption how many members are there and income of family, but generally is taken that females are the one who care about cooking so also about buying different food from the markets (Bhandari 2000). Regarding to female's role in the household and factors which influence decision making of consumers was done research by Sharma et al. (2013). Several factors were felt essential such as decision making. Monthly income of the family was found as the critical factor. The buying pattern of daily commodities influenced taste and preferences of the consumers especially children. Woman and men have different expectation, want, need, life-style etc. reflect to their consumption behaviours, therefore gender has an important role in consumer behaviour (Akturan 2009). Men and women have fundamentally different set of characteristics. On the one side women showing more sensitivity, warmth and apprehension than man. In the contrast dominance, vigilance, emotional stability are characteristics typical for men even though both approach problems with similar goal but different consideration (Lakshmi et al. 2017). According to results of the study done by Dibsall et al. (2007) it was mentioned that females are more willing to buy more vegetables and fruits for their health and prevention to cancer and other health problems. Even though gender

distribution of our respondents was balanced, our statistical analysis showed that in case of aquatic vegetables in Phnom Penh gender was not statistically significant. In term of aquatic vegetables gender do not influence consumption of five selected species of vegetables. According to our results, gender was not relevant in case of consumption aquatic vegetables because all species were consumed by men and women without differences. Aquatic vegetables are part of the meals every day and are consumed by all citizens. Gender could influence consumption of different goods also because of household structure, head of household and household patterns. Females usually obtain housework and cooking what corelate with buying aquatic vegetables in the markets but consumption of selected aquatic vegetables in Phnom Penh is not affected by gender. Reason of differences between results from questionnaire survey and scientific articles could be that consumption of these kind of vegetables is high in all groups unbound to gender.

Age is one of the important demographic factors which could affects consumer behaviour (Holbrook & Schindler 1994). People's needs are changing within their age and their buying decision making patterns are influenced in the similar way. Age brings some changes to people's lifestyle, health needs and also personal values are affected. Young people spend more on their lifestyle in comparison health related expenses could rise for elderly people. For these reasons, age becomes one of the important demographic factors affecting consumer behaviour (Verbeke 2004; Pratap 2017). Survey done by Dibsall et al. (2007) was focused on consumption of vegetables and fruit. Respondents were spit according to age groups and with increasing age was recorded increasing of consumption vegetables and fruit. Older participants were more likely to believe that higher amount of vegetables and fruits in their eating habits is healthier (Dibsall et al. 2007). In our detail analysis it was found that age play important role to consumption of aquatic vegetables thereby it was confirmed scientific articles which are focused on consumers' attitude and how socio-demographic characteristics influence consumers' behaviour. Three species of aquatic vegetables were considered as the most influenced one from five selected aquatic vegetables. Especially in case of Fish mint age effected in four scale three

elements – daily, from two to four days and one day and less per week. Consumption of Water convolvulus and Cambodian mint was considered as vegetables directly influence by age. On the other hand, in cases of Water dropwort and Water mimosa was not proved significant correlation between consumption and age. Dependency of two variables (age, consumption) was confirmed for aquatic vegetables.

Education level is an important factor associated with status and with a demand for security and proception of life, health, food security and consuming attitudes. With higher education level is potential growing purchase insurance as a tool allowing them better access to high security for their properties (homes, food, cars, etc.) (Inocica et al. 2012). Education improve ability to identify, locate, and assimilate relevant information (Kulviwat et al. 2004). Education has a power to influence consumer behaviour, improvement of education level in specific areas and regions may supply marketers with opportunities to sell sophisticated products and services (Chisnall 1994). People with higher education attach less importance to symbolic aspect in purchasing products which they consumed but importance of quality if significantly growing with education level (Creusen 2010). According to data from survey done by Posri et al. (2008) it was proved that respondents who could reached higher education were more familiar with questions relevant to health conscious of some types of food. Data showed that education influence choice of people and willingness to pay for better quality food. In many developing countries education is the one of the most important challenges which should be improve. This socio-demographic element effect consumers behaviour and could be used for higher life quality (Posri et al. 2008). Our research was also focused on to determinate education level of the respondents. As it was already mentioned above, education could very significantly influence consumers behaviour and was set up as one of the most relevant characteristic for decision making of consumers. Our analysis showed that education level is statistically significant and influence consumption of four types chosen aquatic vegetables (Water dropwort, Water mimosa, Fish mint, Cambodian mint). In case of Water mimosa, it was found that this characteristic effect from daily consumption to two days per week. Our research

confirmed that education level is important factor for consuming aquatic vegetables and could influence consumer behaviour and decision making. One of the reasons which can influence decision to buy aquatic vegetables is better knowledge relevant to the issues of health risk and heavy metals in water where these vegetables are grown.

Rural households are less dependent to the food market and are able to produce products for their own consumption in opposite side 93% of urban households are dependent on food markets (El-Noush 2010). Even though production aquatic vegetables and fishes are directly in and around the capital city quite high. According to survey done by Khov et al. in 2005, average family live around the Boeung Cheung Ek Lake is able to collect daily 300-400 bunches (0.3 kg per bunch) of water spinach, which is sold fresh to the local markets. Aquatic vegetables account for nearly half of the total sales of vegetables in Phnom Penh (Khov et al. 2005). According to the Cambodia's Centre for Policy Studies (2017), imports aquatic vegetables from the neighbouring countries is increasing last years and price for these vegetables is much lower than were established from local's farmer what have effect that farmers are losing four-fifths of consumers, because exactly this amount took foreign vegetables. Comparison of prices two most consumed aquatic vegetables (Water convolvulus, Water mimosa) are significant different. Water convolvulus costs around 0.03 USD per kg in contrast with Water mimosa which costs around 0.38 USD per kg in markets in Phnom Penh. The capital city Phnom Penh was established as study area because of high concentration of consumers and markets but high amount of producers these products in urban area (Khov et al. 2005). In our research the significant percentages in daily consumption were found in respondents living in rural areas but just in case of two types of aquatic vegetables (Fish mint, Cambodian mint). Furthermore, respondents living in urban area consumed all five types of vegetables daily even though percentages are a little bit lower. This could be by effect of better access to more types of vegetables on the markets even though not all of them were produced by local farmers. The fact that urban household are much more depend on the markets and are not able to produce enough amount of different type of food make

consumption of all species of aquatic vegetables higher than in rural household. Farmers cultivate just some types of aquatic vegetables and the others must buy on the local markets. In our research the consumption was directly influenced by residence in two types of aquatic vegetables: Fish mint and Water mimosa.

Aquatic vegetables are grown in wetlands or lakes around the Phnom Penh and the fact that in this city there is no waste water treatment plant means that 10% of waste flows directly to the Mekong and 90% is loaded into the natural wetland around the city (JIP 1999). Cultivation of aquatic vegetables is an important activity for many families living around lakes. The official function of Beung Chenung Ek wetland is flood control and removal of pollutants from the city. High metal concentration of water especially lead, and mercury directly influence many families, which are in direct contact during harvesting and collecting aquatic vegetables. These toxic metals influence many other consumers because these vegetables are in daily eaten by all Cambodians as a part of daily meals (Muong 2004). Polluted water influences around two hundred families living around Beung Cheung Ek Lake by different skin diseases as dermatitis and fungal infection from direct contact with water (Hoek et al. 2005). Lead is considered as a potential carcinogen and is associated with a number of diseases as cardiovascular, nervous system as well blood and bone diseases (Jarup 2003). Health risk was found also in long term period consuming heavy metals as decreasing immunological defence, intrauterine growth retardation, impaired psycho-social faculties, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates (Nair 2000; Türkdogan et al. 2003). One of the really dangerous elements is cadmium because it could be absorbed via the alimentary tract, penetrate through placenta during pregnancy and could damage membranes and DNA. Cadmium could persist in human body from 16 to 33 years and is directly connected to several health problems as renal damages or abnormal urinary excretion of proteins (WHO 2004). Vegetables could contribute to about 70% of cadmium intake by humans, what depends on level of consumption these kind of vegetables (Wagner 1993; Guerra et al. 2012). Lead has many toxic effects on several organs such as liver, kidneys, spleen and lung a variety of biochemical

defects. Almost all types of vegetables could get toxic metals through water pollution. Guerra et al. (2012) published detail analysis of many samples of vegetables and their toxicity by different heavy metals. Spinach could cumulate around 0.13 milligram cadmium per kilogram and more than 1.00 milligram lead per kilogram, both of these elements are in long term consumption highly dangerous for human health (Guerra et al. 2012). Aquatic vegetables are daily consumed by all Cambodian even though the health risk from toxic metals from waste water in wetlands is quite high. However, these types of vegetables have ability to bond nitrogen and different types of elements from water where are growing. Our analysis showed that almost 80% of respondents considered as beneficial for their health and good quality products in the local markets. According to our results relatively low percentages of respondents are aware of presence heavy metals in water in which aquatic vegetables grow. One of the reasons could be that these products are daily part of local meals and many local citizens have no choice to buy higher quality products. Percentage of respondents with higher education background is quite low what could affect knowledge about risk relevant to waste water floating directly into wet lands where are cultivated plants. Awareness of respondents about possible contamination of aquatic vegetables is not high even though many of researches relevant to this topic proved that problem of waste water and with heavy metals is significant with which close related health risks.

6.1 Limitation of the research

The study was mainly focused on consumption of aquatic vegetables in the capital city Phnom Penh and a part of study was to determinate assessment of respondent to access in the local market, quality and health conscious of aquatic vegetables. The study does not provide laboratory analysis of samples collection directly from wetland and in the markets. This could make research more complex in term of real contents of particular heavy metals in aquatic vegetables. Other limitation of the questionnaire survey was dependency on willingness locals to participate and elimination of discussion because of language barrier.

7. Conclusion

The thesis main objective of the study was to get relevant information about consumption of aquatic vegetables by Cambodian consumers and evaluate awareness of respondents to potential health risk due to concentration of heavy metals in wet land of cultivation aquatic vegetables. Aquatic vegetables represent one of the most common part of the meals across whole Cambodia. This research was conducted among five selected aquatic vegetables produce mainly in three wet lands (Boeng Trabek, Boeng Tompun, Boeng Cheung Ek) and questionnaire survey was done in the capital city Phnom Penh due to high concentration of consumers. The field research demonstrate that education level, occupation and residence are statistically significant for consumption of aquatic vegetables. High consumption of aquatic vegetables was proved in case of all chosen species of vegetables. Respondents reported low awareness of contamination and health risk from long term consumption of contaminated aquatic vegetables. To decrease the risk, local population should be educated to be aware of heavy metals contamination and be able to choose higher quality vegetables. Further developing of research could be focused on concentration on the amount of heavy metals in samples of aquatic vegetables.

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Appendixes

Appendix I: Questionnaire

1. How many times a week is this vegetables part of the diet?

	<1day	2 - 4 days	5 - 6 days	daily
Water convolvulus (Ip...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water dropwort (Oena...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water mimosa (Neptu...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fish mint (Houttuynia ...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cambodian mint (Poly...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. Where do you buy aquatic vegetables?

	Never	Rarely	Sometimes	Often	Very often
Open Market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organic market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Super Market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Directly from far...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Growing by my o...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How do you use aquatic vegetables?

	Cooked	Raw	Fried	None
Water convolvus (Ipo...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water dropwort (Oena...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water mimosa (Neptu...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fish mint (Houttuynia ...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cambodian mint (Poly...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. How important are following characteristics when you buy aquatic vegetables?

	Not important	Neutral	Important
Taste	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Price	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hygiene	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Place of origin	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Color	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Are you willing to buy vegetables with higher quality for a higher price?

- Strongly yes
- Yes
- Neutral
- No
- Strongly no

6. Do you realize some these risk of illness by eating and colecting aquatic vegetables?

- Dermatitis
- Fungal infection
- Anemia
- Indigestion
- Autoimmune disease
- Other (please specify)

7. Would you agree with stronger regulation considering hygienic/quality standard?

- Strongly yes
- Yes
- Neutral
- No
- Strongly no

8. Aquatic vegetables are easily accessible in the local market.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

9. Quality of aquatic vegetables on local market is good.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

10. Aquatic vegetables are beneficial for your health.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Interviewee's Profile

1. Area of employment

- Agriculture
- Services
- Industry
- Bussines-economy
- Student

2. Age

- < 25
- 26 - 40
- 41 - 50
- > 51

3. Sex

- Male
- Female

4. What is your residence?

- Urban area
- Rural area
- Sub-urban area

5. What year of schooling did you complete?


- Primary school
- Secondary school
- High school
- Universtiy
- None

6. What is your martial status?

- Single
- Married
- Divorced
- Widow/Widower

7. How many members are in your household?

- 1 - 2
- 3 - 4
- 5 - 6
- 7+

8. How many members are in productive age? 

1-2

3-4

5-6

7+

9. Do you have stable income?

Agree

Neutral

Disagree

10. If yes: What is level of your income?

< 600.000 KHR

600.000 - 800.000 KHR

> 800.000 KHR

Appendix II: Harvesting of aquatic vegetables



Appendix III: Interview on the market

