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Evaluation of Shellfish Consumption in Nha Trang City, Southern Coastal Vietnam

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ABSTRACT

Introduction: Shellfish consumption may be a significant pathway to food contaminants such as heavy metals, pesticides and phycotoxins. Currently, little information exists about consumption of shellfish in Vietnam. Such data could be of interest in terms of nutritional value or risk assessment. **Methods:** Consumption of shellfish was assessed using a food frequency questionnaire and validated by a 7-day recall method. Approximately 1% of the city population of Nha Trang was selected yielding a final sample of 440 participants. The participants were above 18 years of age, in apparently good health and were shellfish consumers. **Results:** In South coastal Vietnam, the types of shellfish most consumed are green mussel, squid, crab and shrimp. The mean consumption rates of the bivalves, crustaceans, gastropods, cephalopods, echinoderms and all shellfish combined were 39.3, 20.9, 16.4, 11.2, 0.3 and 88.1 g/person/day, respectively. The consumption rate was slightly higher in the age group of 30-54 years, than in the younger (18-29 years) and older (55 years and above) age groups. Shellfish is essentially purchased in the markets and temporary markets, and mostly consumed during the dry season. **Conclusion:** Shellfish consumption in the Southern coastal region of Vietnam is high compared to consumption levels in other countries; it is also high compared to consumption levels of Vietnamese emigrants. Such data may be useful for further investigation on nutrition perspectives and in term of risk assessment of shellfish contaminants.

Keywords: Food frequency questionnaire, shellfish consumption, Vietnam

INTRODUCTION

Vietnam has a long coastline of 3,260 km from the North to the South of the country. Much of the fishing industry is concentrated in the Southern coastal provinces, from Khanh Hoa to Ca Mau where there are plentiful supplies of fresh seafood. In this part of Vietnam, seafood especially shellfish is not only considered a nutritious food, but also a recreational food. The Southern coastal inhabitants are believed to consume higher quantities of shellfish compared to the general population. However, the consumption of contaminated shellfish may pose a risk to human health (Anderson &

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Rice, 1993). In order to be able to assess the exposure to food contaminants and to perform a risk assessment, the first step is to estimate the level of shellfish consumption.

There are limited studies on Vietnamese aquatic products consumption. In the study by Mubarik, Nguyen & Ngo (2006), aquatic products consumption data was determined in North Vietnam. It is not possible to extrapolate that data to estimate shellfish consumption in southern Vietnam owing to cultural and environmental differences between the different parts of the country. In the EPA (1999) study, the shellfish consumption rate of Vietnamese immigrants in the United States was estimated. The aim of this study is to obtain shellfish consumption data reflecting shellfish consumption rates and patterns of the adult population living in the southern part of Vietnam (Nha Trang City). Such information could serve as a basis for future work on evaluating exposure to contaminants through shellfish consumption.

METHODS

The Nha Trang inhabitants reside in 27 strata / wards based on the administrative classification of the city. Within each ward, 1% of the households were randomly selected yielding a sample of 688 households. That value was obtained using the Cochran formula (Bartlet, Kotrlik & Higgins, 2001; Israel, 2009) and increased in order to take into account sub-groups who might not respond to the study questions. Stratification was applied in order to limit errors and uncertainties (EPA, 2003) owing in part to non-response by sub-groups. Representativeness of the sample was computed by applying the classical correction method based on ponderation ratios (over-represented sub-populations are reduced in order to attain their representative level). In this manner, all subgroups are assured of being found in the final sample.

Within each household, one adult subject was randomly selected from the adults. The prospective participants had to be at least 18 years of age, shellfish consumers and in apparently good health. Refugees, vegetarians, non-consumers of shellfish, people who were ill, pregnant and lactating women were excluded from the sample.

A food frequency questionnaire (FFQ) was used to assess shellfish consumption of adults living in Nha Trang City. The subjects were requested to provide information on their consumption frequency during a pre-defined period. The FFQ focused on 5 shellfish groups: (1) bivalves (clams, oysters, mussels, scallops); (2) gastropods (snails, limpets, abalone); (3) cephalopods (squid and octopus); (4) crustaceans (crabs, shrimps, lobsters); and (5) echinoderms (sea urchins and sea cucumbers). A collection of pictures and physical models of the different shellfish species were used throughout the survey to assist the respondents in identifying the different shellfish species. In order to estimate the weight of each portion, the shellfish of the size typically consumed, and from which models were made, were purchased. The flesh was removed and its shell pieces were glued together and mounted on a foam board. The flesh weight for each species was determined by weighing the usual edible parts. When a subject chose a picture as representing the size of the shellfish consumed, the weight of that product could be obtained from the prepared list.

A 7-day recall method was applied to the retained respondents of the Food Frequency Questionnaire. This was done in order to validate the FFQ for total consumption of shellfish, and consumption of 4 sub-groups, namely bivalves, crustaceans, gastropods and cephalopods.

Statistical analysis

All statistical analyses were performed using the SPSS version 16. According to the distribution of the data (Kolmogorov-

Smirnov test), either the parametric methods (*t*-test or One-Way ANOVA) or non-parametric methods (Mann-Whitney test or Kruskal-Wallis) were chosen to assess statistically significant difference, depending on the number of groups being compared. $p<0.05$ was considered statistically significant. Due to the skewed distribution, the Spearman correlation coefficient was used to describe the association between two variables (Cade *et al*., 2002; Motulsky, 1999). Analyses of consumption rates are presented in terms of mean, median and 95th percentiles. The daily consumption rate (g / person / day) for each respondent was calculated by the following equation:daily consumption rate in g per day = (edible fraction x frequency per year x portion size in grams) / 365 days.

Ethical approval

This work was approved by the Ethical Committee of the University of Brest (France). All respondents gave informed consent to the use of their responses.

RESULTS AND DISCUSSION

Among the original 688 households selected, 137 (19.9 %) refused to respond to the study questions while 32 (4.7%) could not be contacted. Among those contacted, 79 (11.5 %) were disqualified because they did not meet all of the selection criteria. Finally, the population surveyed consisted of 440 individuals with all fulfilling the criteria of consuming at least one type of shellfish. There were slightly more women (51%) than men (49 %).

The mean, median and 95th percentile of consumption rates of all types of combined shellfish were 88.1, 86.2 and 143.8g / person / day, respectively. The consumption rates among individuals and the types of shellfish consumed varied widely. Bivalves, crustaceans, gastropods, cephalopods were consumed by 98%, 99%, 89% and 63% of the respondents, respectively. They showed high consumption rates for these shellfish at 39.3, 20.9, 16.4 and 11.2 g / person / day, respectively. Echinoderms were not popular as they were consumed only by 16% of the respondents and that too with a low consumption rate of 0.3 g / person / day. The most frequently consumed shellfish species and in the biggest amounts in Nha Trang were green mussels (89% and 12.8 g / person / day), followed by squid (82% and 10.6 g / person / day), crab (74% and 8.8 g / person / day), and shrimp (72% and 8.2 g / person / day). Consumption of urchin and sea cucumber was found to be low (10% of the respondents and 0.2 g / person / day and 9% and 0.2 g / person / day, respectively).

More than 50% of the respondents consumed ten different types of shellfish species namely, green mussel, squid, crab, shrimp, scallop, oyster, cuttlefish, half-crenate ark, poker chip venus and strawberry conch. The mean consumption rate of over 4 g / person / day was reported for nine shellfish species, including five bivalves (green mussel, scallop, Asiatic hard clam, oyster and poker chip venus), one cephalopod (squid), two crustaceans (crab and shrimp) and one gastropod (strawberry conch) (Table 1, Figure 1). Less commonly consumed species included granular ark, Asiatic hard clam, green mud crab, common spider conch, krill, and areola babylon.

There were significant differences between men and women with regard to consumption of the bivalves, gastropods, and cephalopods. While women consumed more bivalves than men, the latter ate more gastropods and cephalopods.

The mean consumption rate of all shellfish combined for the age groups of 18-29 years, 30-54 years, and 55 years and over were 84.4, 95.3 and 81.6 g / person / day, respectively. There were significant differences between the three age groups with regard to consumption of bivalves and all shellfish. The age group of 30-54 years consumed the highest amount of bivalves,

Table 1. Mean, median and 95th percentile shellfish consumption (g/person/day)

		n=440			
Group	Shellfish	Mean	Median	SD	95th
Bivalves	Green Mussel	12.8	10.1	11.6	35.0
	Granular Ark	1.5	0.0	2.5	8.6
	Hakf- crenate Ark	3.6	0.1	5.8	18.4
	Scallop	4.6	2.1	5.0	12.5
	Grand Jackknife Clam	1.7	0.0	3.8	12.4
	Asiatic Hard Clam	4.3	0.0	5.3	12.5
	Oyster	4.9	1.7	5.6	14.8
	Bicolor Pen Shell	1.4	0.0	2.7	8.7
	Poker Chip Venus	4.5	0.2	6.7	19.0
Crustacean	Shrimp	8.2	0.2	13.7	37.1
	Penicilated Shrimp / Krill	1.3	0.0	1.6	3.8
	Lobster	1.0	0.0	2.1	5.7
	Green Mud Crab	1.6	0.0	1.9	4.6
	Crab	8.8	11.2	6.6	16.4
Gastropod	Common Turtle Limpet	2.2	0.0	3.5	8.6
	Donkey's Ear Abalone	0.2	0.0	0.4	1.1
	Screw Turritella	0.2	0.0	0.4	1.3
	Pyramid Top	1.4	0.0	2.8	7.2
	Strawberry Conch	6.5	2.2	7.3	19.0
	Common Spider Conch	1.9	0.0	2.3	5.8
	Orange Spider Conch	0.7	0.0	1.2	3.2
	Areola Babylon	3.2	0.0	4.9	12.9
	Vesta's Button Top	0.1	0.0	0.2	0.5
Cephalopod	Squid	10.6	5.8	11.1	29.4
	Cuttlefish	0.6	0.1	0.8	2.1
Echinoderm	Sea Urchins	0.2	0.0	0.5	1.7
	Sea Cucumbers	0.2	0.0	0.6	1.7
		39.3	38.0	18.8	73.4
	Bivalves	20.9	18.0	15.5	50.6
	Crustacean	16.4	16.6	15.4	41.1
	Gastropod	11.2	7.3	11.2	30.9
	Cephalopod	0.3	0.0	0.8	2.2
	Echinoderm	88.1	86.2	30.9	143.8
	Shellfish				

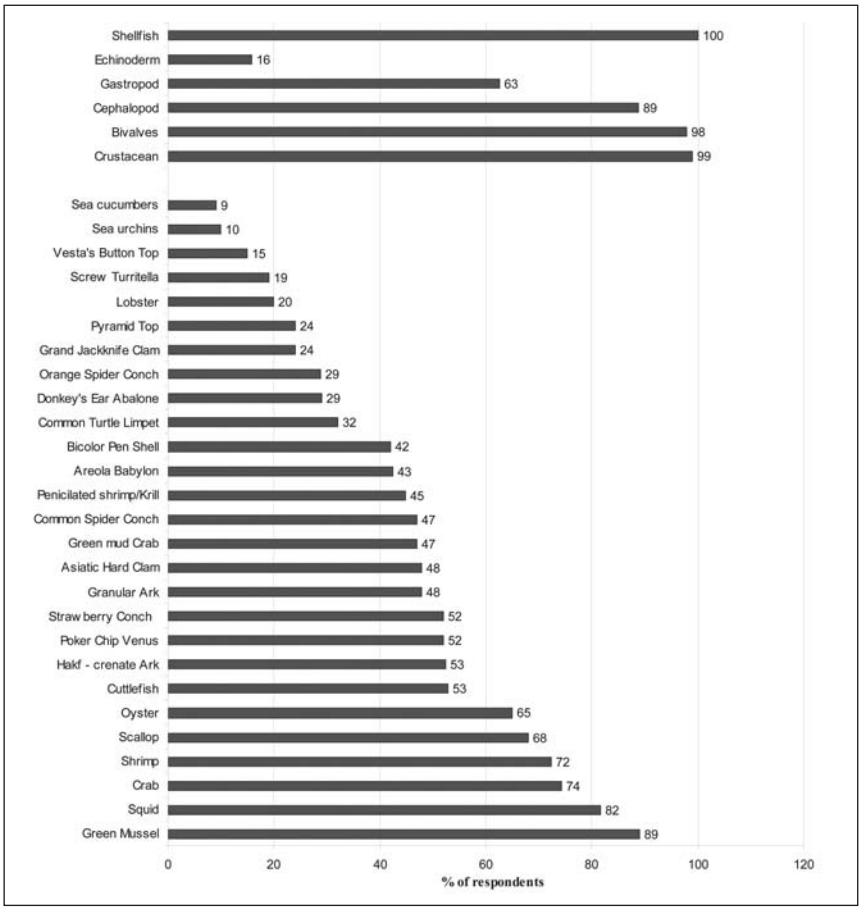

Figure 1. Respondents who consumed shellfish species (%)

crustacean, gastropods and cephalopods. Consumption of shellfish by income levels was not significantly different.

The market is the major source for the purchase of shellfish (55% of all shellfish), followed by the temporary market (30%). The temporary market is defined as a place that does not belong to the legal market system established by authorities, neither is it recognised by the authorities as a market place, nor is it permanent (Mubarik *et al*., 2006). In this type of market, the prices are usually lower than elsewhere because the shop owners do not have to pay any market fees (although they may have to pay bribes to certain authorities). The third principal source of shellfish was the restaurants (10%). In fact, shellfish species were easily found in all the markets and restaurants of Nha Trang. Shellfish prices in the markets were cheaper than in the restaurants. Supermarkets and fishing ports only provided 3% and 2% of shellfish, respectively.

The shellfish parts consumed depend on the specific shellfish species. More than 50% of the respondents consumed the entire flesh (with viscera) of bivalves, gastropods and crustaceans. In contrast, more than half of the respondents consumed only the edible parts (without viscera) of cephalopods, echinoderms and lobsters. All the respondents consumed the whole flesh (with viscera) of krill (Figure 2). The bivalves,

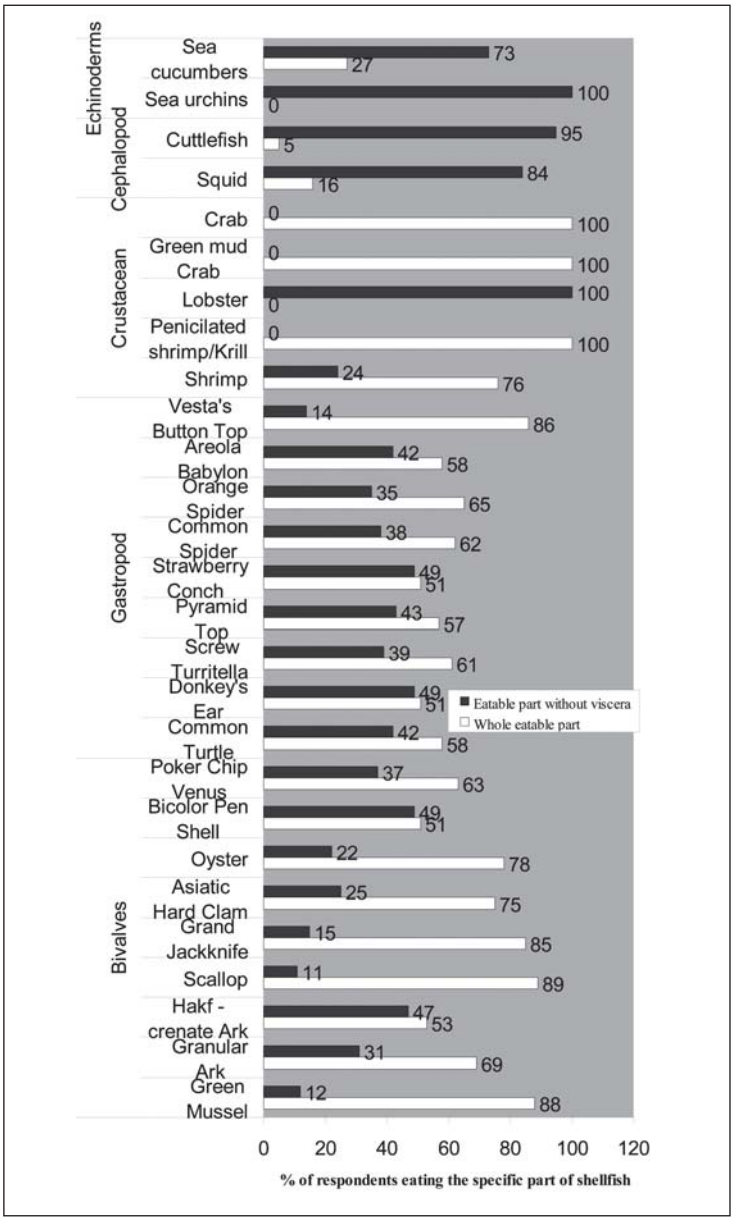

Figure 2. Respondents who consumed all shellfish parts, or edible parts without viscera (%)

gastropods and crustacean viscera, such as the siphon and the stomach, are tasty and small, whereas cephalopod and echinoderm viscera are fairly bitter. However, it is the clam stomachs' siphon or hepatopancreas that usually contain high concentrations of chemical contaminants.

Shellfish are usually consumed raw, fried, dried or baked. Bivalves are prepared by these methods as reported by 56% of the subjects; so are gastropods (54% of the cases), and cephalopods (65% of the cases). Eating raw mussels may lead to higher intake of cadmium than eating cooked mussels (CAC, 2009).

Table 2. Comparison of shellfish consumption data in Asia

Country / population	Species	Mean Consumption's (g / person / day)	Reference
Japan (1996)	C, O, Cr	22.6	Nakagawa *et al.*, 1997
China (Hong Kong)	Shellfish	50	CAC, 2009
Cambodian (expatriates in the USA)	Shellfish	57.0	EPA, 1999
Lao (expatriates in the USA)	Shellfish	55.6	EPA, 1999
Mien (expatriates in the USA)	Shellfish	21.1	EPA, 1999
Hmong (expatriates in the USA)	Shellfish	15.3	EPA, 1999
Vietnamese (expatriates in the USA)	Shellfish	97.8	EPA, 1999
Vietnam (North population)	Aquatic products	46.2	Mubarik *et al.*, 2006
Vietnam (Nhatrang population)	Crustacean	20.9	This study
Vietnam (Nhatrang population)	Cephalopod	11.2	This study
Vietnam (Nhatrang population)	Shellfish	88.1	This study

C: Cuttlefish ; O: Octopus ; Cr: Crustacean

Boiled and steamed shellfish as well as shellfish soup tend to leach out the contaminants. These preparation methods were preferred for echinoderms by 84% of the cases and for crustaceans (76% of the cases).

Approximately 82% of the shellfish consumers indicated that they ate least shellfish during the months of October through March and 76% of the shellfish consumers indicated that they ate more shellfish during the months of April to August. In general, the highest shellfish consumption season spanned from April to August (dry season) and the lowest from November to March (wet season). During the wet season, shellfish are not as abundant and are more expensive than during the dry season.

Based on the dietary recall method (results not shown), it was found that the majority of the subjects consumed shellfish during the 7 days preceding the interview. The mean shellfish consumption rate was 36.5 g / person / day during this period. The distribution of the consumption rates of the 440 respondents from the 7-day recall was compared to the distribution of their all year-round consumption rates obtained from the FFQ. The two distributions were positively correlated (Spearman's r= 0.437, $p<0.01$), which indicated a consistency between the two methods. However, the shellfish mean consumption rate measured by the 7-day dietary recall method was lower than that estimated by the FFQ method. A similar finding was shown in other studies (Toy *et al*., 1996; Ducan, 2000). Actually, there were only 4 groups of shellfish in the 7-day dietary recall study instead of 5 groups in the FFQ, as the former lacks the echinoderm group. In theory, in a validation step, the FFQ method should be compared to an alternative, but not necessarily more accurate, method. A validation study can only indicate whether the methods give related answers. According to Cade *et al*., (2002), globally, 75% of the studies validated a FFQ against another dietary method.

The data obtained in this study were compared to shellfish consumption data in Asia (Table 2). Given that the methods used in these surveys are different and that the shellfish species are not the same, comparisons should be done cautiously. Shellfish consumption data in Vietnam were not available except for aquatic production consumption data in northern Vietnam (Mubarik *et al*, 2006). However, it is not possible to extrapolate the shellfish

consumption data from the aquatic products consumption data in northern Vietnam to other parts of Vietnam. Besides, consumption patterns vary within the same country as a result of different local eating habits and shellfish supplies. The mean shellfish consumption (88.1g / person / day) found in this study was higher than the mean aquatic products (including fish and shellfish) consumption (46.2 g / person / day) reported in northern Vietnam (Mubarik *et al*, 2006). In the Asian region, the contribution of seafood to the daily animal protein intake of the population was highest in Vietnam (67.2%), followed by Philippines (54%) but less important in Hong Kong (30%) (FAO, 1989). The mean shellfish consumption rate (88.1 g / person / day) in this study was slightly lower than that of Vietnamese expatriates in the USA (97.8 g / person / day) but higher than the levels of Cambodian, Lao, Mien and Hmong expatriates (57, 55.6 and 15.3 g / person / day, respectively) (EPA, 1999). The present study level is also higher than that for China (Hong Kong) (50 g / person / day) (CAC, 2009). Besides, the mean crustaceans and cephalopods consumption rates in Southern coastal Vietnam were higher than those in Japan (Nakagawa, Yumita & Hiromoto, 1997) (Table 2).

In regions worldwide, the consumption of crustaceans and mollusks among Australian and New Zealander adults were very similar to that in Southern coastal Vietnam (Greening *et al*, 2003; HC, 2007). The mean shellfish consumption in Southern coastal Vietnam was higher than the levels of Squaxin Island and Asian Pacific Islander community in the United States and slightly lower than the shellfish consumption rate for adults of Tulalips Tribe and Suquamish Tribe (Toy *et al*., 1996; Ducan, 2000; Sechena *et al.*, 2003). However, the mean shellfish consumption in Southern coastal Vietnam was almost twofold higher than in France (Leblanc *et al.*, 2006) and eightfold higher than in Chile (CAC, 2009) and in the United States (Degner, Adams & Moss, 1994).

In general, a comparison of shellfish consumption rates obtained in this study with the ones obtained in others studies in Asia as well as in the world shows that the data are in the same order of magnitude with the shellfish consumption rate of the Southern coastal Vietnamese population being slightly higher.

CONCLUSION

This is perhaps the first survey conducted in Vietnam to determine shellfish consumption rates and patterns. Comparison of the mean shellfish consumption rates obtained in this study with those from other studies in Asia and worldwide show that the Vietnamese Southern coastal population consume slightly higher levels of shellfish. Therefore, this population should be an interesting target for risk assessment due to shellfish contamination. The results of this study will be useful for evaluating the exposure of the Southern coastal Vietnamese population to shellfish contaminants and for performing risk assessment.

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