

RESEARCH COMMUNICATION

Cooking Temperature, Heat-generated-carcinogens, and the Risk of Stomach and Colorectal Cancers

Le Tran Ngoan^{1*}, Nguyen Thi Thu¹, Nguyen Thi Lua¹, Lai Thi Minh Hang¹, Nguyen Ngoc Bich¹, Nguyen Van Hieu¹, Ha Van Quyet¹, Le Thi Tai¹, Do Duc Van², Nguyen Cong Khan², Le Bach Mai², Shinkan Tokudome³, Takesumi Yoshimura⁴

Abstract

Background: Food change due to cooking temperature and unrecognized heat-formed chemical carcinogens may impact on the risk of stomach and colo-rectal cancers. To test this hypothesis a case-control study was performed. **Methods:** A total of 670 cases of stomach and colo-rectal cancers matched with 672 hospital controls for sex and ± 5 years age admitted to three hospitals in Hanoi city in the North Viet Nam from October 2006 to September 2007 were the subjects. Five levels of food change due to cooking temperature were based on food color; white, pale yellow, yellow, dark yellow, and burnt. We asked study subjects to themselves report which of these five colors was their preferable intake before the onset of disease. The present study included; fried fishes-meats-eggs-potato-tofu; grilled foods; roasted foods; sugar, bread, heated wheat, and biscuits. These were cooked at temperatures as high as from 165 to 240°C, based on the literature. Adjusted estimation of odds ratio was conducted controlling for possible confounding factors using STATA 8.0. **Results:** A high intake of roasted meats, bread and biscuit significantly increased the risk of cancer as much as OR=1.63, 95%CI=1.04-2.54; OR=1.40, 95%CI=1.03-1.90; OR=1.60, 95%CI=1.03-2.46 with probabilities for trend = 0.029, 0.035, and 0.037, respectively. For exposure among controls: 529 (79%) were not exposed at all to roasted meats; 449 (67%) were not exposed at all to bread; and 494 (74%) were not exposed at all to biscuit. **Conclusions;** Observation of food change due to cooking temperature based on color is practically feasible for detecting associations with risk of developing cancer.

Key Words: Cooking - food colour - risk factor - gastric cancer - colorectal cancer

Asian Pacific J Cancer Prev, 10, 83-86

Introduction

Except man, all species intake unheated foods and cancer among rarely occurs because carcinogens, like acrylamide, have not been detected in unheated food (Tareke et al., 2002). Man worldwide daily intakes heated foods that are boiled, fried, roasted, grilled, and undergo other types of heating. Moderate levels of acrylamide (5-50 $\mu\text{g}/\text{kg}$) were measured in heated protein rich foods and higher contents (150-4,000 $\mu\text{g}/\text{kg}$) in carbohydrate-rich foods at cooking temperatures from 100°C-240°C (Tareke et al., 2002). Vietnamese foods are commonly heated foods, such as fried fishes-meats-eggs-tofu; grilled foods; roasted foods; bread, biscuit and other heated foods. They were hypothesized to be sources of dietary carcinogens that cause cancer in man. However, very few epidemiological studies have been performed in Viet Nam. The present study aimed to examine the relationship between intakes of heated foods and the risk of stomach

and colo-rectal cancers by case-control study in the North Viet Nam.

Materials and Methods

Case-control study was performed for stomach and colorectal cancers admitted to Hanoi Cancer Hospital, Viet Duc Surgery Hospital and Bach Mai General Hospital located in the Hanoi city from October 2006 to September 2007. One incidence case was matched with one incidence control for sex and age ± 5 years. Cases and controls were operated on at these three hospitals and bed-side interview one day before operated on to collect data of demographic and lifestyle questionnaire (DLQ) and semi-quantitative-food-frequency questionnaire (SQFFQ) was done. Blood samples were collected early morning after waked up on the day of operated on. Interviewers were students of bachelor of public health four grade of the Hanoi Medical University. They were trained to interview patients at

¹Hanoi Medical University, ²National Nutrition Institute, Hanoi City, Viet Nam, ³National Institute of Health, Tokyo, ⁴Fukuoka Institute of Health and Environmental Sciences, Fukuoka, Japan *For Correspondence: letngoan@hmu.edu.vn

hospitals using the list of selected patients by independent person. Cases and controls were not informed to the interviewers to keep blind data collection using DLQ & SQFFQ.

Development of the SQFFQ

Based on the database of national household survey of food consumption in 2000, the analysis was done basing on surveyed data from Hanoi areas to develop of database SQFFQ for the purpose of the Epidemiological Study of Host and Environmental factors for Stomach and Colorectal Cancers. A total of 158 households (5 clusters multiplying around 30 households per cluster) living in Hanoi participated in a 24- hour recalls survey during September 2000. The unit of survey is a household. 24-hour recalls: The 24-hour recalls survey was carried out on one weekday. Direct interviews were done in the households by 2 investigators from the National Institute of Nutrition. Total time for interview for each subject was around 45 minutes. Investigator interviewed the household about all foods recipes consumed by themselves at their house or outside during last 24 hours.

Nutrients of interest

Based on the Vietnam Food Composition Tables, the following 17 nutrients were selected: energy, protein, fat, carbohydrate, dietary fiber, vitamins (including carotene, vitamin A, C, B1, and B2), and minerals (including calcium, phosphorus, iron and Zinc). In total, 184 kinds of foods were consumed by the subjects. The nutrient intake from food was computed by multiplying the food intake (in grams) with nutrient content per gram of food as listed in the Nutritive Composition Tables of Vietnamese food (revision 2000). Selection of foods/ recipes: According to the contribution analysis and also multiple regression analysis, we choose all food/recipes with up to 90% cumulative contribution for these 17 nutrients, then the foods/ recipes having the apparently the similar nutrient contents are grouped. Afterwards, all foods/recipes with up to 90% cumulative contributions and 0.9 cumulative multiple regression co-efficient were included in the SQFFQ. The number of food items was 63.

Additional food items

We have planned to select some food items regarding further estimation of salt intake, cooking methods and drinking habit. They are rice and cereals (1), beans (1), vegetables (4), oils (1), fishes (9), fruits (7), salted food (18), fried food (9), broiled food (7), and beverages (7), total is 64 food items. These 127 food items are included in the same questionnaire. From each patient, information regarding of frequent intake, size of intake unit and number of intake unit per year was obtained. DLQ & SQFFQ included 184 items.

In order to analyze antibodies to *Helicobacter pylori*, 7 ml aliquots of overnight fasting blood were collected from cases and controls. Syringes were shaken gently several times to mix blood and EDTA-2Na, quickly followed by centrifugation at 3,000 rpm for 20 minutes in a centrifuge with a low temperature control. Using

disposable pipettes samples were divided into 4 tubes for plasma, one tube for Buffy coat and one tube for RBCs. These were all to be kept frozen in a deep freezer. The name, number and the date sampled was clearly marked on the tubes, with different colors of tube caps for plasma, lymphocytes and RBCs. Each disposable kit was used for only one person and then discarded. DNA was extracted from the Buffy coat for two candidate genes of GSTM1 and CYP1A1.

Food change due to cooking temperature:

Milk-pork (Two month-old) was roasted and it has been colored and smoked gradually. In community, very yellow indicated that foods be cooked, such as fried fishes-meats-eggs-tofu; grilled foods; roasted foods; bread, heated wheat, biscuit and other heated foods. Five levels of food change due to cooking temperature were based on colors from food done to; off-white, pale yellow, yellow, dark yellow, and burnt (Figure 1). We asked study subjects to report by themselves which of these five colors was their preference before the onset of the present ill condition.

Un-recognized heated chemical forming carcinogens:

Reference to acrylamide levels among fried foods: Concentrations of acrylamide at 120-160-200°C are reported to be 217-808-3479 µg/kg, respectively (Tareke et al., 2002). The present study included fried fishes-meats-eggs-potato-tofu; grilled foods; roasted foods; make color by heating sugar, bread, heated wheat, and biscuit that have been heated as high temperatures as from 165 to 240°C (Masako, 1984; Stephanie et al., 2001). Therefore, number of un-recognized heated chemical forming carcinogens was hypothesized to be sources of dietary carcinogens that cause stomach and colo-rectal cancers.

Identify the risk of stomach and colo-rectal cancers: For seven food items of fried fishes-meats-eggs-potato-tofu, grilled foods, roasted foods, three levels of exposures were grouped, such as never intake, medium intake and high intake. For other five food items of make color by heating sugar, bread, heated wheat, and biscuit, three levels of exposures were grouped, such as some time per year or never intake (Low), monthly intake (Medium) and daily or weekly intake (High) exposed. Three cancer sites of stomach and colorectal cancers were coded as cancer to do analysis. Data were computer-inputted and tabled for 184 question-items to describe for cases and controls for three levels of exposures. Then we estimated crude odds ratios for items suggested a moderated exposure to the individual factor. Final adjusted estimation of odds ratio was done for crude odds ratios with significantly increased risk of cancer in controlling for a possible confounding factors using STATA 8.0.

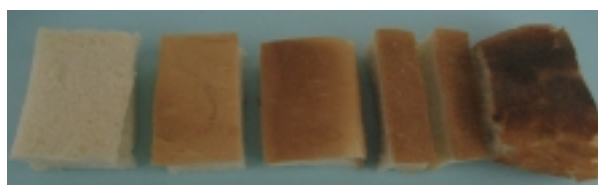


Figure 1. Color Gradation from Off-white to Burnt

Results

The number of stomach and colo-rectal cancers was 670 and there were 672 controls for the final analysis. There was 162 cases of stomach cancer (64.3%) and 309 cases of controls (65.5%) positive for *Helicobacter pylori*

Table 1. Odds Ratios by Exposure Level

Items/Exposure	Number		Odds Ratio	95% Confidence Interval	P
	Controls	Cases			
Q55: Fried fishes					
Low #	170	211	1.00		
Medium	462	416	0.73	0.57-0.92	-
High	38	45	0.95	0.59-1.54	-
Q56: Fried Meats					
Low	313	367	1.00		
Medium	312	232	0.63	0.50-0.80	
High	45	73	1.38	0.93-2.07	-
Q57: Fried eggs					
Low	202	217	1.00		
Medium	459	432	0.88	0.69-1.11	
High	9	23	2.38	1.08-5.26	-
Q58: Fried potatoes					
Low	263	313	1.00		
Medium	388	339	0.73	0.59-0.91	
High	19	20	0.88	0.42-1.69	-
Q59: Fried tofu					
Low	163	191	1.00		
Medium	492	461	0.80	0.63-1.02	
High	15	20	1.14	0.56-2.29	-
Q60*: Grilled foods (200-240°C)					
Low	434	443	1.00		
Medium	150	100	0.65	0.49-0.87	
			0.50*	0.35-0.73	
High	86	129	1.47	1.09-1.90	0.023
			1.21*	0.85-1.72	0.392
Q61 *: Roasted meats (240°C)					
Low	529	502	1.00		
Medium	96	90	0.99	0.72-1.35	
			1.53*	1.02-2.30	
High	45	80	1.87	1.27-2.75	0.002
			1.63*	1.04-2.54	0.029
Q70: Make color by heated sugar					
Low	561	538	1.00		
Medium	76	89	1.22	0.88-1.69	
High	33	45	1.42	0.89-2.26	-
Q80*: Bread (165°C)					
Low	449	405	1.00		
Medium	122	135	1.23	0.93-1.62	
			1.14*	0.85-1.53	
High	99	132	1.48	1.10-1.98	0.007
			1.40*	1.03-1.90	0.035
Q83 *: Heated wheat					
Low	331	274	1.00		
Medium	120	149	1.50	1.13-2.00	
			1.47*	1.09-1.98	
High	219	249	1.37	1.08-1.75	0.017
			1.31*	1.02-1.69	0.106
Q148 *: Biscuit (200°C)					
Low	494	467	1.00		
Medium	139	140	1.07	0.82-1.39	
			1.02*	0.77-1.34	
High	37	65	1.86	1.22-2.84	0.006
			1.60*	1.03-2.46	0.037

Low exposed or never intake-non-exposed; *Adjusted for age, sex, and other factors; P for trend

infection. There was also GSTM1 positive from 29.5 to 31.1% among controls, stomach cases, colon cancer cases and rectal cancer cases; CYP1A1 positive from 73.6 to 87.3%. There were not significantly differenced between cases and controls for these factors in the present study.

Based on crude odds ratio, high exposure to five factors included grilled foods, roasted foods, bread, heated wheal, and biscuit have been seen to be significantly increased the risk of cancer. After adjusted for these five factors with age and sex, high intake of roasted meats, bread and biscuit significantly increased the risk of cancer as much as OR=1.63, 95% CI=1.04-2.54; OR=1.40, 95% CI=1.03-1.90; OR=1.60, 95% CI=1.03-2.46 with Probability for trend = 0.029, 0.035, and 0.037, respectively (Table 1). For exposure among control cases, 529 controls (79%) were not exposed at all to roasted meats; 449 controls (67%) were not exposed at all to bread; and 494 controls (74%) were not exposed at all to biscuit.

Discussion

Food change due to cooking temperature has been well known by three observations: i) weight lost from 14.9-55.0% according to cooking temperatures ranked from 100-220°C, ii) Occurred acrylamide-corrected values from 146-2,273 µg/kg (Tareke et al., 2002), iii) Color of food changed from food done to a turn-white; pale yellow, yellow, very yellow, and burnt. Based on these facts and figures, we can observe food changes due to cooking temperature and therefore to develop epidemiological study to promote cancer prevention at household and community.

Unrecognized heated-chemical-forming-carcinogens (HCFC) has been concerned: Man's foods contaminant about 10,000 chemical additives and we have almost no knowledge of the potential danger of any one of these (Adams, 1970). By heating temperature as high as 950°C, there are about 3,800 heated-chemical-forming chemicals included number of carcinogens (IARC, 1985). Dietary carcinogens or heated-chemical-forming-carcinogens (HCFC) should be significantly examined to prevent cancer in human because man in the earth now a day eats almost heated foods.

The risk of developing cancer could be measured: Single chemical carcinogen is induced tumour in rat (Sugimura and Fukimura, 1967). Therefore, chemical carcinogens of HCFC are also presented a similar potential in production of tumour. The present study supported to this hypothesis and confirmed risk of developing stomach and colo-rectal cancers.

In conclusion, observation of food change due to cooking temperature were based on colors of cooked foods is practically, feasible and reliability to detect an association of food change due to cooking temperature, unrecognized heated-chemical-forming-carcinogens (HCFC) and the risk of developing cancer. The present study detected for an association of a high intake of roasted meats, bread and biscuit significantly increased the risk of cancer as much as OR=1.63, 95% CI=1.04-2.54; OR=1.40, 95% CI=1.03-1.90; OR=1.60, 95% CI=1.03-2.46 with Probability for trend = 0.029, 0.035, and 0.037,

Acknowledgement

The present study was supported in part by the Viet Nam Government, the Japanese Government (Monbukagakusho) and Ministry of Science and Technology of Viet Nam, Hanoi Medical University, National Institute of Nutrition, Viet Duc and Bach Mai Hospitals, Hanoi Cancer Hospital. We specially thank students of Bachelor of Public Health for their volunteer work to do data collection at hospital to complete the present study.

References

- Adams RC (1970). Natural foods. *New Eng J Med*, **283**, 1058.
- IARC (1985). Tobacco Smoking. Lyon: IARC Press.
- Masako Y (1984). A first book of Japanese Cooking. First Edition ed. Tokyo-New York-London: Kodansha International.
- Stephanie A, Maggie B, Tetsuya W, Damien P, Christine M (2001). The food of Austratlia. First Edition ed. Boston and Singapore: Periplus Editions (HK) Ltd.
- Sugimura T, Fujimura S (1967). Tumour production in glandular stomach of rat by N-methyl-N-nitro-N-nitrosoguanidine. *Nature*, **216**, 943-4.
- Tareke E, Rydberg P, Karlsson P, Eriksson S, Tornqvist M (2002). Analysis of acrylamide, a carcinogen formed in heated foodstuffs. *J Agric Food Chem*, **50**, 4998-5006.