World Journal of Gastroenterology

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DOI: 10.3748/wjg.v20.i27.8971

World J Gastroenterol 2014 July 21; 20(27): 8971-8978
ISSN 1007-9327 (print) ISSN 2219-2840 (online)

TOPIC HIGHLIGHT

WJG 20th Anniversary Special Issues (6): *Helicobacter pylori*

Natural products and food components with anti-*Helicobacter pylori* activities

Hiroaki Takeuchi, Vu Thu Trang, Norihito Morimoto, Yoshie Nishida, Yoshihisa Matsumura, Tetsuro Sugiura

Hiroaki Takeuchi, Norihito Morimoto, Yoshie Nishida, Yoshihisa Matsumura, Tetsuro Sugiura, Department of Clinical Laboratory Medicine, Kochi Medical School, Kochi 783-8505, Japan
Vu Thu Trang, School of Biotechnology and Food Technology, Hanoi University of Science and Technology, Hanoi 12771, Vietnam
Author contributions: Takeuchi H designed and performed research, and wrote the paper; Trang VT performed research and contributed analytic tools; Morimoto N and Nishida Y contributed analytic tools; Matsumura Y and Sugiura T analyzed data.
Supported by JSPS KAKENHI Grant, No. 24590697 and No. 24590698; and the Vietnam National Foundation for Science and Technology Development (NAFOSTED, 106.99-2011.22)
Correspondence to: Hiroaki Takeuchi, PhD, Department of Clinical Laboratory Medicine, Kochi Medical School, Kohasu, Oko-cho, Nankoku-city, Kochi 783-8505, Japan. htake@kochi-u.ac.jp
Telephone: +81-88-8802427 Fax: +81-88-8802428
Received: September 27, 2013 Revised: January 20, 2014
Accepted: April 1, 2014
Published online: July 21, 2014

Abstract

The bacterial pathogen *Helicobacter pylori* (*H. pylori*) colonizes in over half of the world's population. *H. pylori* that establishes life-long infection in the stomach is definitely associated with gastro-duodenal diseases and a wide variety of non-gastrointestinal tract conditions such as immune thrombocytopenia. Triple therapy which consists of a proton pump inhibitor and combinations of two antibiotics (amoxicillin, clarithromycin or amoxicillin, metronidazol) is commonly used for *H. pylori* eradication. Recently, the occurrence of drug-resistant *H. pylori* and the adverse effect of antibiotics have severely weakened eradication therapy. Generally antibiotics induce the disturbance of human gastrointestinal microflora. Furthermore, there are inappropriate cases of triple therapy such as allergy to antibiotics, severe complications (liver and/or kidney dysfunction), the aged and people who reject the triple therapy. These prompt us to seek alterative agents instead of antibiotics and to develop more effective and safe therapy with these agents. The combination of these agents actually may result in lower a dose of antibiotics. There are many reports world-wide that non-antibiotic substances from natural products potentially have an anti-*H. pylori* agent. We briefly review the constituents derived from nature that fight against *H. pylori* in the literature with our studies.

Key words: Anti-*Helicobacter pylori* effect; Natural product; Food component; *In vitro* and *in vivo* effects; Human health; *Helicobacter pylori* treatment; Combined effect

Core tip: The present review summarized the natural products and food components with anti-*Helicobacter pylori* (*H. pylori*) activities in the literatures and showed the possibility for its application on human health. There are many promising *in vitro* effects on *H. pylori* and other infections (infectious diseases). Next, further *in vivo* evidence is required. There are many guidelines for *H. pylori* treatment which are not always the same among countries. Thus, we should address the evaluation of *in vivo* effects using such components in clinical investigation to make an adequate guideline useful for all countries for the application on *H. pylori* treatment.

Takeuchi H, Trang VT, Morimoto N, Nishida Y, Matsumura Y, Sugiura T. Natural products and food components with anti-*Helicobacter pylori* activities. *World J Gastroenterol* 2014; 20(27): 8971-8978 Available from: URL: http://www.wjgnet.com/1007-9327/full/v20/i27/8971.htm DOI: http://dx.doi.org/10.3748/wjg.v20.i27.8971

INTRODUCTION

The bacterial pathogen *Helicobacter pylori* (*H. pylori*) colonizes in over half of the world's population[1]. *H. pylori* that establishes life-long infection in the stomach is definitely associated with gastro-duodenal diseases and a wide variety of non-gastrointestinal tract conditions such as immune thrombocytopenia[2,3]. Foods and the components possessing anti-*H. pylori* activity are summarized in Table 1. Anti-*H. pylori* effects and combined effects with agents in clinical trial are summarized in Table 2.

LACTOFERRIN

Lactoferrin is a multifunctional iron-binding glycoprotein found in milk (human and bovine), neutrophils, saliva and lacrimal fluid. The inhibitory activity of bovine lactoferrin (bLF) against *H. pylori* is known *in vitro* and animal experiments using BALB/c mouse[4]. Clinical trials were performed to evaluate whether oral administration of bLF suppressed *H. pylori* colonized in the stomach with bLF alone or with a combination of bLF and antibiotics[5-7]. The clinical study with a combination of bLF and antibiotics in 150 consecutive *H. pylori*-positive patients showed a 100% eradication rate[5], which was significantly higher than those without prescription. Similarly, Di Mario *et al*[6] indicated that the eradication rate of a combination of triple therapy and bLF was 93%, significantly higher than the other two groups; triple therapy without bLF or administrating before triple therapy. On the other hand, a randomized, double-blind, placebo-controlled study with 59 *H. pylori*-positive patients indicated that administration of bLF alone effectively suppressed the colonization of *H. pylori* in the stomach[7]. Anti-*H. pylori* activity of human lactoferrin was reported *in vitro*[8], but not in clinical trials[9,10]. These results showed that bLF could be a new effective agent against *H. pylori* and could enhance the eradication rate when combined with antibiotics. The possible mechanism of bLF is that the cationic lactoferrin binds to the anionic cell wall materials and allows a greater penetration of the antibiotics.

GREEN TEA (CATECHIN COMPOUNDS)

Among the catechin compounds, epigallocatechin-3-gallate (EGCg) showed the lowest MIC against *H. pylori*. The anti-*H. pylori* activity of EGCg obviously exhibited itself even in the antibiotic-resistant [amoxicillin (AMPC), metronidazole (MNZ) and clarithromycin (CAM)] isolates and showed additive effects in regard to antibiotics[11]. In Mongolian gerbils, the eradication rate of EGCg was 36.4% due probably to the inhibition of *H. pylori* urease activity[12]. However, green tea catechins (GTCs) failed to show any clear-cut activities against *H. pylori* *in vivo*. The most likely reason for the *in vivo* inefficacy was the short gastric transit time of GTCs. Solutions of GTCs adsorbed to sucralfate (GTC-scf) were used in animal experiments to prolong the gastric transit time of GTCs. As a result, colony forming unit of *H. pylori* in the stomach significantly decreased using GTC-scf compared to solutions of GTCs[13]. The administration of green tea polyphenol in a drinking water dose-dependently suppressed *H. pylori* infection in Mongolian gerbils[14]. One of the postulated mechanisms of suppression by green tea polyphenols against *H. pylori* infection was the inhibition of urease activity *via* disturbance of cell membrane, leading to the prevention or even eradication of *H. pylori* infection[14]. Another proposed mechanism, the blockage of toll-like receptor 4 activation by EGCg was reported[15]. Anti-*H. pylori* activity of epicatechin gallate was second next to EGCg, and hence pyrogallol and gallate substituent groups of catechin compounds are an important element of antimicrobial activity.

POLYPHENOL COMPOUNDS

Ginger (*Zingiber officinale*) belonging to the family Zingiberaceae is cultivated world-wide. Dietary plant phenolic compounds have been shown to exert varieties of biological actions including anti-*H. pylori* activity. The effective compounds possessing anti-*H. pylori* activity were identified as 6-gingerol, 8-gingerol, 10-gingerol, 6-shogaol and phenolic acids and their derivatives. The aqueous and ethanol extracts of ginger inhibited the growth of antibiotic-resistant *H. pylori in vitro*[16]. In addition, the combined use of ginger extract and CAM strengthened growth inhibition of *H. pylori* with synergic and additive effects *in vitro*[17]. The methanol extract of ginger containing 6-gingerol, 8-gingerol, 10-gingerol and 6-shogaol also effectively inhibited the growth of CagA-positive *H. pylori*[18]. Siddaraju *et al*[19] reported that ginger-free phenolic (GRFP) and ginger hydrolysed phenolic (GRHP) fractions of ginger inhibited *H. pylori* growth *in vitro*. GRHP with higher content of cinnamic and coumaric acid showed better inhibition than GRFP, indicating that phenolic acids have anti-*H. pylori* activity. Similar effectiveness was reported with phenolic fractions of *Curcuma amada*, known as mango ginger[20]. Mango ginger free phenolics including caffeic, gentisic and ferulic acids, and mango ginger bound phenolics including ferulic, cinnamic and p-coumaric acids inhibited *H. pylori* growth *in vitro*. Turmeric (*Curcuma longa*) possesses curcumin, the major polyphenolic constituent. Both the methanol extract of the dried powdered turmeric rhizome and curcumin inhibited the growth of all *H. pylori* strains examined *in vitro*[21].

Propolis, a resinous hive product collected by honeybees, is composed of resins (flavonoids and a various kinds of polyphenols), wax, essential oils and organic compounds. Propolis exhibits antimicrobial activity with inhibitions of bacterial motility and enzyme activity most likely due to the damage of cytoplasmic membrane[22]. Anti-*H. pylori* activities of Brazilian propolis and Bulgarian propolis were found by *in vitro* studies[23,24]. The labdan-type diterpenes and some of the prenylated phenolic compounds in Brazilian propolis were putative antimicrobial constituents derived from propolis[23]. Furthermore, the combined use of propolis extract and CAM increased

Table 1 Foods and products posessing anti-*Helicobacter pylori* potential

Food	Putative active component	Stage of experiment	Ref.
Bovine milk	Lactoferrin	*In vitro*, *in vivo* (animal) *in vivo* (human)	[4-10]
Green tea	Catechin compounds	*In vitro*, *in vivo* (animal)	[11-15]
Ginger (*Zingiber officinale*)	6-gingerol, 8-gingerol, 10-gingerol, 6-shogaol, phenolic acids (cinnamic, caffeic, ferulic, syringic, p-coumaric, protocatechuic, gentisic, gallic)	*In vitro*	[16-19]
Curcuma amada	Phenolic acids (cinnamic, caffeic, ferulic, syringic, p-coumaric, protocatechuic, gentisic, gallic)	*In vitro*	[20]
Turmeric (*Curcuma longa*)	Curcumin	*In vitro*	[21]
Propolis	Phenolic compounds	*In vitro*	[17,22-24]
Acacia nilotica	Unknown (phenolics, alkaloids, terpenes, flavonoids, tannins)	*In vitro*	[25,26,28]
Calotropis procera	Unknown	*In vitro*	[27,28]
Muscadine grape skin	Polyphenols (quercetin, resveratrol)	*In vitro*, *in vivo* (animal)	[29,30]
Apple peel	Quercetin glycosides	*In vitro*	[31,32]
Virgin oil	Phenolics	*In vitro*, *in vivo* (human)	[33,34]
Cranberry (Vaccinium macrocarpon) Cranbery juice	Polyphenol compound	*In vitro*, *in vivo* (human)	[35-37]
Plants	Tannins (tellimagrandin- Ⅰ, - Ⅱ)	*In vitro*	[38]
Broccoli sprout (*Brassica oleracea*)	Sulforaphane	*In vitro*, *in vivo* (animal), *in vivo* (human)	[39,40]
Paeonia lactiflora	Paeonol, benzoic acid, unknown	*In vitro*	[41-43]
Decalepis hamiltonii	2-hydroxy-4-methoxy benzaldehyde (HMBA) Unknown	*In vitro*	[44,45]
(Maillard reaction products)	Melanoidin	*In vitro*, *in vivo* (animal), *in vivo* (human)	[46]
(Maillard reaction products)	Aminoreductone	*In vitro*	[47]
Milk (Maillard reaction products)	Casein polymer (FP-10),	*In vitro*, *in vivo* (animal); *in vivo* (human)	[48,49]
Okinawamozuku (*Cladosiphon okamuranus*)	Fucoidan	*In vitro*, *in vivo* (animal)	[50,51]
Garlic (*Allium sativum*)	Allicin, diallyl sulfur components	*In vitro*	[52-55]
Chinese chive (*Allium tuberosum*)	Unknown	*In vitro*	[56]
Deep seawater	Unknown	*In vitro*, *in vivo* (animal); *in vivo* (human)	[63]
Essential oils	Unknown (geranial in lemongrass)	*In vitro*, *in vivo* (animal)	[64-66]

the anti-*H. pylori* activity with synergic and additive effects *in vitro*[17].

The plant *Acacia nilotica* (*A. nilotica*) contains phenolics, alkaloids, terpenes, flavonoids and tannins[25] as secondary metabolites, which exhibits beneficial function for human health[26]. *Calotropis procera* (*C. procera*), a wild-growing plant, has multifarious medicinal and biological properties[27]. Amin *et al*[28] demonstrated that methanol and acetone extracts of *A. nilotica* and *C. procera* exhibited stronger anti-*H. pylori* activity than MNZ, but not AMPC and CAM. The anti-*H. pylori* activity was due to the suppression of *H. pylori* urease activity.

Muscadine grapes (*Vitis rotundifolia*), common in the south-eastern United States, have unique anthocyanin profiles and high flavonoid concentrations. Brown *et al*[29] previously reported that muscadine grapes exhibited anti-*H. pylori* potential *in vitro* through their major phenolic compounds acting alone or in synergy. Anti-*H. pylori* effects of quercetin and resveratrol, active polyphenols identified in muscadine grape skin (MGS) extracts, were confirmed *in vitro* experiment irrespective of the pH condition[30]. In the case of *in vivo* tests on mice, MGS and quercetin did not significantly reduce *H. pylori* growth but regulated the inflammatory response to *H. pylori* infection[29]. The concentration of polyphenols in apple peel could be up to three times higher than that found in the pulp. Apple peel polyphenols derived from a standardized apple peel extract (APPE, 60% of total polyphenols; 58% of flavonoids; 30% of flavan-3-ols and procyanidins) was investigated for anti-*H. pylori* activity on a few strains *in vitro*[31,32]. APPE (mainly quercetin glycosides) showed growth inhibition of *H. pylori via* suppression of urease activity and inhibited the respiratory burst of neutrophils induced by *H. pylori* leading to the protection of gastric mucosa.

Virgin olive oil, one of the few edible vegetable oils that are consumed unrefined, contains a significant amount of phenolic compounds. Extracts of virgin olive oil and a very low concentration of the pure dialdehydic form of decarboxymethyl elenolic acid linked to tyrosol (TyEDA) effectively killed the *H. pylori in vitro*[33]. A successful eradication with administration of virgin olive oil was confirmed in two clinical trials consisting of 60 *H. pylori*-infected adults (30 subjects per trial). These data revealed[34] a moderate effectiveness of virgin oil in eradication of *H. pylori*. Further studies are necessary to confirm these findings including administration conditions, types of olive oils and combination with common antibiotics.

Native Americans have conveniently used cranberry

Table 2 Anti-*Helicobacter pylori* effects and combination effects in clinical studies

Food	Putative anti-*H. pylori* effect	Effect comminbed with agents in clinical trial			Ref.
		Agents	Eradication rate	Study design	
Bovine milk	Penetration of the antibiotics to *H. pylori*	bLF + triple therapy	100%	Open, randomized, single-center	[5]
	(damage of cell membrane)	(rabeprazole, CAM, tinidazole)	93%	Open, randomized, multi-center	[6]
Green tea	Inhibition of urease activity *via* disrupted cell membrane				
Ginger (*Zingiber officinale*)	Blockage of Toll-like receptor 4 (TLR4) activation				
Curcuma amada	-				
Turmeric (*Curcuma longa*)	-				
Propolis	Damage of cytoplasmic membrane				
Acacia nilotica	Suppression of urease activity				
Calotropis procera	Suppression of urease activity				
Muscadine grape skin	-				
Apple peel	Inhibition of urease activity				
Virgin oil	-				
Cranberry (Vaccinium macrocarpon)	Inhibition of *H. pylori* adhesion to gastric mucosa	Cranbery juice + *Lactobacillus* (La1)	22.90%	Multicentric, randomized, controlled, double-blind	[37]
Cranbery juice					
Plants	Damage of lipid bilayer membrane				
Broccoli sprout (*Brassica oleracea*)	-				
Paeonia lactiflora	Inhibition of urease activity				
Decalepis hamiltonii	Bacterial lysis (cell death) (interference of DNA/protein involved in DNA protection and bioavailability)				
(Maillard reaction products)	Inhibition of *H. pylori* urease binding to gastric mucin				
(Maillard reaction products)	-				
Milk (Maillard reaction products)	Blockage of interaction between *H. pylori* and gastric mucin				
Okinawamozuku (*Cladosiphon okamuranus*)	Inhibition of *H. pylori* binding to gastric cell				
Garlic (*Allium sativum*)	-				
Chinese chive (*Allium tuberosum*)	Interference of the cell division process				
Deep seawater	-				
Essential oils	-				

H. pylori: *Helicobacter pylori*; CAM: Clarithromycin.

(*Vaccinium macrocarpon*) originated in North America for infectious diseases. Burger *et al*[35] reported that certain high molecular constituents of cranberry juice inhibited *H. pylori* adhesion to human gastric mucus *in vitro*. Direct *in vitro* study using cranberry, polyphenol-rich fruit, documented that the extracts effectively suppressed *H. pylori* proliferation compared to other polyphenol-poor fruits (oranges, pineapples, apples, and white grapes). The polyphenol-rich fraction obtained by ion-exchange column chromatography showed a higher growth inhibition of *H. pylori* than that of the sugar/organic acid-rich fraction. Thus, the effective antimicrobial component in cranberry is thought to be polyphenol compounds[36]. Interestingly, a clinical trial with a combination of cranberry juice and probiotic *Lactobacillus johnsonii* La1 (La1) in 271 *H. pylori*-infected children assigned into 4 groups was performed[37]. The eradication rates of 4 groups were 1.5% (placebo juice/heat-killed La1), 14.9% (placebo juice/La1), 16.9% (cranberry juice/heat-killed La1) and 22.9% (cranberry juice/La1), respectively ($P < 0.01$). The highest rate was found in the group who had been administrated cranberry juice/La1 but showed no statistical significance between placebo juice/La1 and cranberry juice/heat-killed La1 groups. These suggested that regular intake of cranberry juice or La1 may be useful in the management of asymptomatic children colonized by *H. pylori*. However, no synergistic inhibitory effects on *H. pylori* colonization were observed when both foodstuffs were simultaneously consumed.

Tannins are naturally occurring plant polyphenols and well known to be present in various materials such as fruits, tea, chocolate, coffee, legume forages, legumes, trees and grasses, *etc*. *In vitro* study with 36 polyphenols and 4 terpenoids from medicinal plants, monomeric hydrolyzable tannins such as tellimagrandin I and II revealed especially strong bactericidal activity with the damage of lipid bilayer membranes[38].

SULFORAPHANE

The sulforaphane, abundant in broccoli (*Brassica oleracea*) sprout in the form of its glucosinolate precursor, exhib-

ited bactericidal activity against *H. pylori* including antibiotic-resistant strains *in vitro* assay[39]. *In vivo* study (animal and human) with administration of glucoraphanin (precursor of sulforaphane)-rich broccoli sprouts was reported[40]. The bacterial colonization of *H. pylori*-infected C57BL/6 female mice treated with broccoli sprout was significantly reduced and the broccoli sprout attenuated gastric inflammation (gastritis) in *H. pylori*-infected mice. Furthermore, in a clinical trial with 48 *H. pylori*-positive patients, 70 g/d of glucoraphanin-rich broccoli sprouts was consumed for 8 wk. As a result, the levels of clinical laboratory examinations (urea breath test and *H. pylori* antigen in the stool) were significantly lower after consumption for 8 wk but reverted to the baseline at 8 wk after the end of the trial. They suggested that the dual actions of sulforaphane were the anti-*H. pylori* activity and the blocking gastric tumor formation due to induction of antioxidant enzymes[40].

PAEONIA LACTIFLORA PALLAS

Paeonia lactiflora (*P. lactiflora*) Pallas (Paeoniaceae) is composed of monoterpene glycosides (albiflorin, benzoylpaeoniflorin, oxypaeoniflorin, and paeoniflorin), monoterpenes (lactoflorin, paeoniflorigenone, and paeonilactones), benzoic acid and its esters, and gallotannins[41]. *P. lactiflora* root was also shown to inhibit the growth of any bacteria[42] except of *H. pylori*. Ngan *et al*[43] reported that paeonol and benzoic acid identified in *P. lactiflora* root possessed a strong *in vitro* bactericidal effect even in the antibiotic-resistant *H. pylori* strains. 1,2,3,4,6-penta-*O*-galloyl-β-*D*-glucopyranose showed a relatively higher inhibition of *H. pylori* urease activity compared to acetohydroxamic acid, suggesting that *P. lactiflora* root globally affected growth inhibition of *H. pylori*.

DECALEPIS HAMILTONII

Pectic polysaccharide from *Decalepis hamiltonii* (*D. hamiltonii*) (Swallow root) containing a sulfonamide group and phenolics was investigated *in vitro* assay. Carbohydrate and pectic polysaccharide of swallow root at a 200 μg/mL concentration exhibited anti-*H. pylori* activity as equivalent to that of AMPC (10 g/mL). Anti-*H. pylori* activity resulted from bacterial lysis observed by the scanning electron microscopy analysis[44]. Later, 2-hydroxy-4-methoxy benzaldehyde (HMBA), identified from the roots of *D. hamiltonii* by the hydrodistillation and cold crystallization method, was shown to inhibit the growth of *H. pylori in vitro*. Increased binding ability of HMBA to DNA and protein involved in DNA protection and bioavailability, leads to cell death of *H. pylori*[45] .

MAILLARD REACTION PRODUCTS

The maillard reaction between amino and carbonyl groups in the food is ubiquitously caused by a thermal process. Melanoidin, the final product of the Maillard reaction, is a high-molecular-weight compound. The *in vivo* effects of melanoidin, prepared by the Maillard reaction between casein and lactose, on *H. pylori* colonized in the stomach of euthymic hairless mice and humans were investigated. Melanoidin I inhibited the binding of urease to gastric mucin and suppressed *H. pylori* colonization in mice as well as in human subjects[46]. These results are critically interesting because melanoidin are common ingredients in a variety of heat-treated foods. Furthermore, the anti-*H. pylori* activity of other Maillard reaction products, aminoreductone (AR), was discovered *in vitro* assay[47]. AR effectively exhibited growth inhibition with bactericidal effects on all 24 *H. pylori* strains including antibiotic-resistant strains. The killing activity of AR was significantly higher than that of its derived melanoidin and was observed even in acidic condition (pH = 3). These results indicated that foods containing AR, such as milk or dairy products are valuable sources for preventing colonization of *H. pylori* in the stomach and its associated tissue damages. Casein polymer (FP-10), made from the casein of milk with maillard reaction, blocked the interaction between *H. pylori* and gastric mucin in the stomach. Therefore, the intake of FP-10 decreased the density of *H. pylori* colonized in the human stomach without serious side effects[48,49].

FUCOIDAN

Similar to melanoidin, polysaccharides are also well known as a high-molecular- weight compound. Among the polysaccharides, fucoidan, one of the sulfated polysaccharides, extracted from Okinawamozuku (*Cladosiphon okamuranus*) was reported to effectively inhibit the binding of *H. pylori* to gastric cell *in vitro*[50]. *In vivo* experiments with Mongolian gerbils, fucoidan reduced the prevalence of *H. pylori*-infected animals and also the onset of *H. pylori*-induced gastritis in a dose-dependent manner[51].

GARLIC (*ALLIUM SATIVUM*) AND CHINESE CHIVE (*ALLIUM TUBEROSUM*)

Garlic, like all allium vegetables, contains a wide range of thiosulphinates such as allicin (allyl 2-propene thiosulfinate) which is thought to be responsible for the antibacterial activity. The allicin in garlic was also reported to show anti-*H. pylori* activity and synergic effect with omeprazole, PPI, *in vitro*[52]. On the other hand, a clinical trial with fresh garlic (10 sliced cloves) or capsaicin-containing peppers (six sliced fresh jalapeños) demonstrated that neither garlic nor capsaicin had any *in vivo* effects on *H. pylori*[53]. Later, *in vitro* effectiveness of the anti-*H. pylori* activity of pure garlic oil and garlic powder and their diallyl sulfur components in a variety of garlic substances were described[54]. Interestingly, the anti-*H. pylori* activity of garlic oil was noticeably affected by food materials and mucin by *in vitro* assay. These data suggested that under suitable fasting or fed conditions in the stomach, admin-

istration of garlic oil might be effective for prevention and treatment of *H. pylori* infections[55]. Furthermore, Chinese chive (*Allium tuberosum*)[56], one of the *Allium* vegetables, definitely inhibited the growth of *H. pylori* strains including antibiotic-resistant isolates *in vitro*. The inhibitory activity of water extracts in Chinese chive was stable under severe stress conditions such as heat and low pH. The water extract did not disturb the antibiotics' activity by combination assay with antibiotics frequently used in clinical practice.

DEEP SEAWATER

Deep seawater is collected at Muroto promontory in Japan. Refined deep seawater (RDSW) produced from deep seawater, a mineral-rich healthy drinking water for humans, is widely consumed. Beyond satisfying the general need for water to support life, RDSW has additional merits for the human body such as hemorheology, allergy and immunology as previously described[57-63]. It should be noted that all types of RDSW have no side effects in long-time heavy consumers or adverse effects in persons with medical problems. Our *in vitro* and *in vivo* studies including animals (Mongolian gerbils) and clinical trial with *H. pylori*-positive patients indicated that RDSW actually exhibited anti-*H. pylori* activity *in vitro* and intake of RDSW significantly decreased the level of urea breath test value in *H. pylori*-infected patients[63]. In addition, amelioration of the intestinal flora condition was observed in RDSW-drinking group. These implicate that the application of RDSW promotes human health and provides eurhythmic body.

ESSENTIAL OILS

Essential oils, which are extracted from plants (*e.g.*, leaves, peels), showed the growth inhibition of *H. pylori in vitro*[64-66] and *in vivo* study with mice[66]. Among 13 essential oils used *in vitro* study, lemongrass oil was utilized *in vivo* study because of the highest MIC *in vitro* experiment. The density of *H. pylori* colonized in the stomach of mice treated with lemongrass oil was significantly reduced compared with untreated mice[66].

CONCLUSION

The great benefits obtained from nature such as milk, plant, vegetable, fruits, water, *etc* are adequate to ameliorate human health. Many foodstuffs have exhibited inhibitory activity against the growth of *H. pylori in vitro* and *in vivo* as reviewed. Furthermore, probiotics and vitamins also possess anti-*H. pylori* potentials and may be readily considered as effective alternative and adjuvant therapy for *H. pylori* treatment. Basically, natural products consumed daily are safe and beneficial for humans. If effective components identified *in vitro* actually show less anti-*H. pylori* activities *in vivo*, intake of these foodstuffs have no serious problem for human health. However, it is better that the effectiveness (merit and demerit) is confirmed *in vivo* experiments, particularly in the clinical trials, at the point of translational medicine. There are many guidelines for *H. pylori* treatment which are not always the same among all countries. We need to evaluate *in vivo* effects using such components in clinical investigation to make an adequate guideline useful for all countries for the application on *H. pylori* treatment. Furthermore, caution must be used when attempting to extrapolate data from *in vitro* studies to the *in vivo* condition. Much effort has been focused on plant preparations and their constituents as potential antibacterial products for prevention or eradication of *H. pylori* and other bacteria. We hope that natural products and food components may be useful for the prevention and/or treatment of *H. pylori* infection as well as in other disorders. Therefore, novel, diet-based therapeutics for use when conventional antibiotic therapies have failed and/or are unavailable, have received considerable attention.

ACKNOWLEDGMENTS

We appreciate that Mr. Ricky Barrow, English teacher, kindly checked the manuscript.

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P- Reviewers: Balbinotti R, Slomiany BL, Sugimoto M
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ISSN 1007-9327