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## **Bamboo leaf extract and bioactive compounds contributing to human health and longevity**

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### **Abstract**

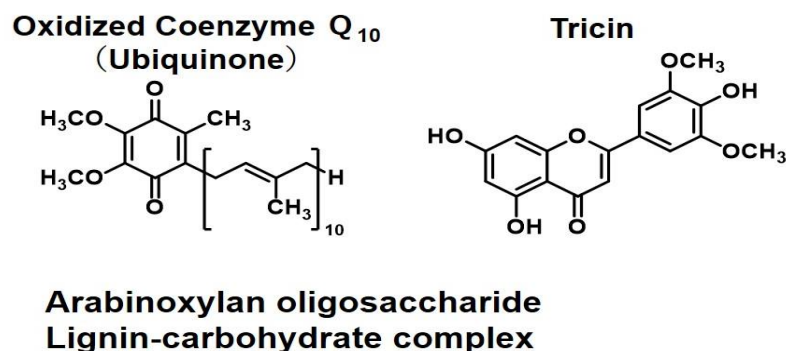
The bamboo (*Sasa senanensis* Rehder var., and *S. kurirensis* Makino et Shibata) leaf extract contains various bioactive compounds, including coenzyme Q<sub>10</sub> (CoQ<sub>10</sub>), triclin, lignin-carbohydrate-complex, arabinoxylan oligosaccharide and others. Therefore, it is expected that these ingredients will contribute to the treatment of various diseases. Our case study showed the potential of CoQ<sub>10</sub> administration to alleviate essential hypertension. In addition, we could demonstrate that bamboo leaf extract inhibits the growth of *Polyphyromonas gingivalis* (periodontal disease bacterium). An interview analysis revealed that some patients determined the self-administration of bamboo leaf extract as a potential therapeutic agent for allergies and fatty liver disease. In fact, some experimental studies have been reported that the bamboo leaf extract alleviated non-alcoholic fatty liver disease and allergy symptoms. These results suggest that bamboo leaf extract, which is reported to prevent infectious diseases, inflammatory diseases, arteriosclerotic diseases, and metabolic diseases, may contribute to keep the healthy longevity by improving various diseases.

**Keywords** Bamboo leaf extract, antibacterial, antihypertensive

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## 1. Introduction

Healthy longevity is an eternal desire of human being. However, many people are suffered from various lifestyle-related diseases. Medical researchers have been engaged in exploration of plant-origin resources useful for the treatment of these diseases. Bamboo leaves are one of the medicinal plants that are widely and naturally distributed throughout Asia. It has been traditionally used as an anti-septic for foods in Japan. Recently, various bioactive compounds (CoQ<sub>10</sub>, triclin, and others) from the bamboo leaf extract have been isolated and chemically identified (Figure 1), and preventive effects against many diseases have been reported (Kimura et al. 2022). In this study, we demonstrated the beneficial effects of components contained in bamboo leaf extract on the basis of the therapeutic effect of CoQ<sub>10</sub> on essential hypertension in our case study, the antibacterial effect for *Polyphyromonas gingivalis* and the analysis of interviews investigating the reasons for self-administration of bamboo leaf extract.



**Figure 1.** Chemical structural formula of components contained in bamboo leaf extract

## 2. Materials and methods

### 2.1 Materials

Shojusen, a combined formulation mainly comprised of bamboo leaf extract, was supplied from Wakan-yaku Medical Institute, Ltd., (Tokyo, Japan), and is commercially available in drug stores in Japan. The formulation (SPG formulation, 31 mg/mL) is comprised of 26.2 mg water extract prepared from *S. senanensis* Reder or *S. kurilensis* MAKINO et SHIBATA, 3 mg/mL ethanol extract from red pine (*Pinus densiflora* SIEB. et Zucc) needle leaf, and 1.8 mg/mL ethanol extract from ginseng (*Panax ginseng* C.A. MEYER) root, and paraben (0.15

mg/mL) as a preservative. The detailed extraction procedure is as described by Asano et al. (2012).

### **Antihypertensive activity**

A Japanese patient with hypertension was enrolled in this study. The case was an 84-year-old woman who had essential hypertension with cardiac hypertrophy in the range higher than 140 mmHg for systolic blood pressure and higher than 90 mmHg for diastolic blood pressure and been treated with candesartan cilexetil (Takeda Pharmaceutical Co., Osaka, Japan) at the outpatient clinic of Toyama University Hospital from June 2001 to 2006. Then, a calcium antagonist (nifedipine, 20 mg of Controlled Release (CR), Bayer, Germany) was prescribed in the outpatient clinic of a local medical doctor from June 2020 until now. Coenzyme Q<sub>10</sub> (30 mg, Pharmavite Co., Northridge, CA, U.S.A.) was orally self-medicated once a day after dinner. Blood pressure was measured 5 times every morning before meal, using a sphygmomanometer (HEM-7000, Omron, Kyoto, Japan; CH-650F, Citizen Systems Co., Tokyo, Japan) that is a fully automated upper-arm blood pressure monitor, and the minimum value for each measurement was used for evaluations. All data for the case report were derived from patient medical records.

### **Anti-bacterial activity**

Anti-bacterial activity was analyzed as described previously (Kimura et al. 2021). In brief, the MICs (minimal inhibitory concentration) of bamboo leaf extract formulation were determined by the agar dilution method principally according to the CLSI (clinical and laboratory standard institute) guidelines M11-A7. Range of MIC (mg/mL) >3.10 mg/mL (= 10 v/v %) means no efficacy.

## **3. Analysis of interview data**

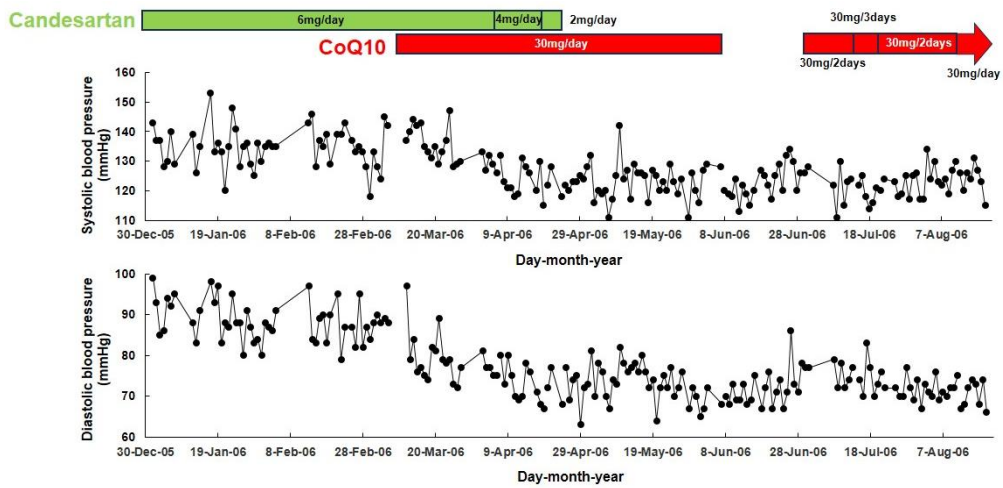
We have summarized the symptoms and their frequency from the interview responses that asked about the motivation for self-administration of bamboo leaf extract formulations. The data was extracted from the Interviewing Reports of 178 pre-symptomatic patients, “Family doctor” from No. 712 (May 2020) to No. 752 (September 2023) by the study group of natural medicines, Wakan-yaku Medical Institute, Ltd., Tokyo, Japan.

## **4. Results and discussion**

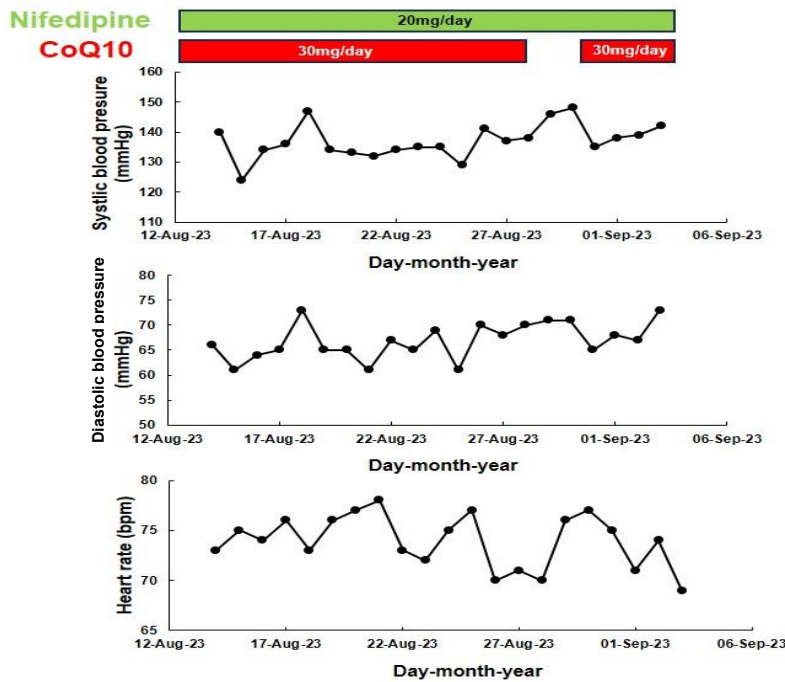
A female patient (age 84) developed hypertension (systolic: >140 mmHg, diastolic: >90 mmHg), cardiac hypertrophy and arrhythmia at the age of 67, and was subjected to a continuous measurement of systolic and diastolic blood pressures. She was prescribed 6

mg/day candesartan cilexetil (an angiotensin II receptor antagonist) by a medical doctor from 2001, but her hypertensive state became uncontrollable in 2004; therefore, she began self-administration with CoQ<sub>10</sub> (30 mg/day) in 2006, and as a result, her systolic and diastolic blood pressures decreased to the range less than 130 mmHg and less than 80 mmHg, respectively (Kimura et al. 2008). These data were reproduced in Figure 2a (with the permission by Biological and Pharmaceutical Bulletin on 11th September 2023). Thereafter, in 2020, she (81 years old) was prescribed nifedipine CR 20 mg/day by another medical doctor at a nearby clinic in addition to self-administration of CoQ<sub>10</sub> (30 mg/day). In 2023, her systolic, diastolic blood pressure and heart rate (age 84) were still lower than 140 mmHg, 80 mmHg, and 80 bpm, respectively. When she stopped the CoQ<sub>10</sub> self-administration for 3 days, the systolic blood pressure rapidly increased, although diastolic blood pressure was kept to be lower than 80 mmHg (Figure 2a and b). Systolic blood pressure may be influenced by weather and psychological stress, and diastolic blood pressure may instead be reflected by arterial stiffness. In this study, we demonstrated that self-administration of CoQ<sub>10</sub> for over 17 years from 67 to 84 years of age could facilitate the antihypertensive effect of angiotensin II receptor antagonist candesartan or calcium channel blocker nifedipine. Tsuneki et al. (2013) demonstrated that CoQ<sub>10</sub> is an efficient antioxidant reagent to improve angiotensin II-induced oxidative stress. Verena et al. (2016) reviewed antioxidant activities and protective effects of nifedipine against oxidative stress-induced damage in low density lipoprotein, mitochondria, microsomes, isolated cells, and cell cultures. Present clinical case data concerning the enhanced antihypertensive effects of CoQ<sub>10</sub> combined may be related to their experimental reports above. Figure 2a and b.

Data concerning the antibacterial activity of the formulation containing bamboo leaf extract (SPG formulation) was reproduced in Table 1 (with permission by Pharmacometrics on 25th August 2023). The bamboo leaf formulations inhibited the growth of *Porphyromonas gingivalis* (Pg) at concentrations between 0.194 and 1.55 mg/mL and *Protera intermedia* (Pi) at concentrations of 0.194 or >3.10 mg/mL. However, it hardly inhibited the growth of other periodontal pathogens, *Fusobacterium nucleatum* and *Veronella parvula*, and did not inhibit the growth of aerobic bacteria (Table 1). The hot water extract of *Sasa albo-marginata*, with triclin isolated from it, has been reported to have anti-human cytomegalovirus activity in MRC-5 cells (Sakai et al. 2008).



**Figure 2(a).** The ameliorating effect of coenzyme Q<sub>10</sub> on essential hypertension in a Japanese woman who self-administered it from 67 to 84 years. (a,b) The blood pressure measured at the age of 67 (a). Figure 2a is reproduced with permission (Kimura et al. Journal of Health Science, 54, 571-575, 2008).



**Figure 2(b).** The blood pressure measured at the age of 84 years (b).

Table 1. Antibacterial effects of SPG formulation

Species	No. of strains	Range of MIC (mg/mL)
<i>Staphylococcus aureus</i>	6	>3.10
<i>Escherichia coli</i>	6	>3.10
<i>Pseudomonas aeruginosa</i>	5	>3.10
<i>Klebsiella pneumoniae</i>	4	>3.10
<i>Klebsiella oxytoca</i>	1	>3.10
<i>Enterobacter cloacae</i>	4	>3.10
<i>Enterobacter aerogenes</i>	1	>3.10
<i>Streptococcus mutans</i>	2	>3.10
<i>Streptococcus mitis</i>	4	>3.10
<i>Porphyromonas gingivalis</i>	4	0.194-1.55
<i>Fusobacterium nucleatum</i>	4	>3.10
<i>Prevotella intermedia</i>	4	0.194 or >3.10
<i>Veillonella parvula</i>	4	>3.10

Reproduced with permission (Kimura et al., Pharmacometrics, 101, 37-44, 2021)

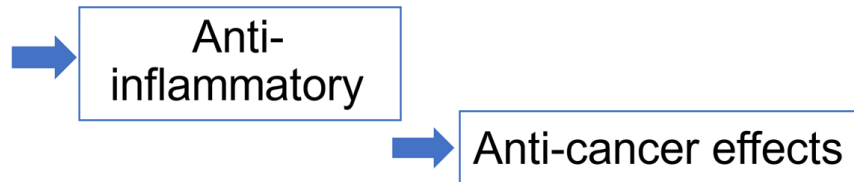
Finally, we investigated the main symptoms that motivate patients to start self-administration of the SPG formulation containing bamboo leaf extract. To this end, we evaluated the frequency of common answers from the interviews (2020-2023). Top syndromes were shown in Figure 3. Consistently, the anti-allergic effects of bamboo leaf extract have been reported in our previous study (Kimura et al. 2021; Kimura et al. 2022). Furthermore, Yosioka et al. (2023) has reported the beneficial effects of bamboo leaf extract against nonalcoholic steatohepatitis in mice, and Tsukiboshi et al. (*in press*) demonstrated that bamboo leaf extract inhibited the proliferation of cultured human palate cells. The antibacterial and anti-viral actions may at least partly underlie the multitasking abilities of bamboo leaf extract to prevent inflammatory disorders and cancer in the peripheral organs and the brain (Figure 4). Thus, the reasons for self-administration of bamboo leaf extract in pre-symptomatic patients appears to be consistent with the results of these experimental studies.

- 37: Cold including sore throat
- 25: Poor circulation
- 24: Essential hypertension
- 18: Lower back pain, Stiff shoulder, Rheumatoid
- 16: Pollen disease, Hives
- 14: Migraine headache, Meniere's disease
- 13: Infection including stomatitis and cystitis
- 12: Cancer
- 12: Constipation, Intestinal obstruction
- 11: Fatty liver disease, Hypercholesterolemia, Hypertriglyceridemia
- 10: Menopausal disorder

**Figure 3.** List of reasons from patients for the selection of bamboo leaf extract. The numbers indicate the frequency of common answers from 178 pre-symptomatic patients in the interviews.

1. Anti-hypertensive effects targeting oxidative stress

2. Anti-microbial  
& Anti-viral



**Figure 4.** The possible mechanism of the multi-tasking bioactivities of bamboo leaf extract.

### **Conclusion**

Bamboo leaf extract has multitasking biological activities, including antihypertensive, anti-infective, anti-inflammatory, and anti-cancer activities that help maintain health in patients. Since bamboo leaf extract and its ingredients have a wide range of effects, they would contribute to healthy longevity in humans.

### **Author declaration**

It is hereby confirmed that the manuscript has been read and approved by the all the named authors and there is no conflict of interest. All regulations of our institution including intellectual property rights have been followed and are no impediments to publication.

### **Conflict of interest**

The authors declare there is no conflict of interest

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