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CLAIR FELLOWSHIP EXCHANGE SEMINAR

Spreading Japanese Tea Abroad & the Health Benefits of Tea

University of Shizuoka Tea Science Center Yoriyuki NAKAMURA

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1. University of Shizuoka Overview
2. Spreading Japanese Tea Abroad
3. Focus to Health Benefits

Slide 3

University of Shizuoka : Past & Present

The University of Shizuoka, by absorbing various prefectural universities established in Shizuoka, came into being in 1987. It combined the Shizuoka College of Pharmacology, originally founded in 1916 as Shizuoka Women's Pharmacology School, along with Shizuoka Women's University and Shizuoka Women's Junior College.

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The University of Shizuoka's Aims

Aims
The University of Shizuoka has the following aims for education, research, contributing to the community and international relations.

Education
Putting students first, we will improve their quality of life and provide fine-tuned, high-level, excellent education, developing human resources who contribute to society.

Research
Aware of being the highest educational institution in Shizuoka Prefecture, we will gather high-level, original academics and promote research that gets international recognition.
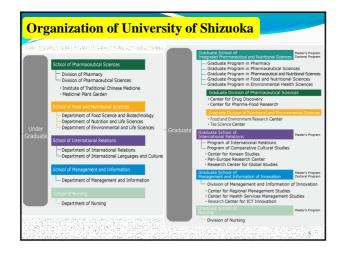
Contributions to the Community
In response to citizen mandates, we will promote ties with the prefectural government and local industry, providing results to the community through research made possible by excellent education and academics.

International Exchange
We will actively take in students and researchers from foreign countries, and by spreading information across the world, strongly promote international relations in Shizuoka Prefecture.

The University of Shizuoka aims to utilize academic and personnel resources to their maximum levels in order to achieve these goals.

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Organization of University of Shizuoka

Under Graduate

School of Pharmaceutical Sciences
- Division of Pharmacy
- Division of Pharmaceutical Sciences
- Institute of Traditional Chinese Medicine
- Medicinal Plant Garden

School of Food and Nutritional Sciences
- Department of Food Science and Biotechnology
- Department of Nutrition and Life Sciences
- Department of Environmental and Life Sciences

School of International Relations
- Department of International Relations
- Department of International Languages and Cultures

School of Management and Information
- Department of Management and Information

School of Nursing
- Department of Nursing

Graduate

Graduate School of Integrated Pharmaceutical and Nutritional Sciences — Master's Program / Doctoral Program
- Graduate Program in Pharmacy
- Graduate Program in Pharmaceutical Sciences
- Graduate Program in Pharmaceutical and Nutritional Sciences
- Graduate Program in Food and Nutritional Sciences
- Graduate Program in Environmental Health Sciences

Graduate Division of Pharmaceutical Sciences
- Center for Drug Discovery
- Center for Pharma-Food Research

Graduate Division of Nutritional and Environmental Sciences
- Food and Environment Research Center
- Tea Science Center

Graduate School of International Relations — Master's Program
- Program of International Relations
- Program of Comparative Cultural Studies
- Center for Korean Studies
- Pan-Europe Research Center
- Research Center for Global Studies

Graduate School of Management and Information of Innovation — Master's Program / Doctoral Program
- Division of Management and Information of Innovation
- Center for Regional Management Studies
- Center for Health Services Management Studies
- Research Center for ICT Innovation

Graduate School of Nursing — Master's Program
- Division of Nursing

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Research activities

Education and research leading to longer, healthier lives

Japan now faces a crisis in the form of a globally unprecedented super-aged society. This has necessitated a nationwide shift to a society in which healthy living is maintained even during old age. Shizuoka Prefecture ranks second among Japan's prefectures for "healthy life expectancy". As an educational and research institution of Shizuoka Prefecture, the University aims to establish a new academic discipline that spans preventative and therapeutic fields.

The University of Shizuoka was selected for the Global Centers of Excellence Program administered by the Japanese Ministry of Education, Culture, Sports, Science and Technology. As a result, the Graduate School of Nutritional and Environmental Sciences and the Graduate School of Pharmaceutical Sciences are working collaboratively on the development of functional health foods and pharmaceuticals for maintenance of health, improving nutrition, and increasing usage rates of efficient pharmaceuticals. The goal of this endeavor is to develop the framework for a new "science of health and longevity," a systematic academic discipline that integrates the nutritional and pharmaceutical sciences.

After the achievements earned over a decade of the COE program, in 2012 the University brought together the Graduate School of Nutritional and Environmental Sciences and the Graduate School of Pharmaceutical Sciences to form the Graduate School of Integrated Pharmaceutical and Nutritional Sciences. This key institution for "science of health and longevity" is currently fostering professionals who possess knowledge in both of the aforementioned fields.

Research into tea

Agriculture and fisheries developed early on in Shizuoka as a result of its temperate climate and rich natural surroundings. Tea cultivation is particularly worth nothing in that crude tea grown in Shizuoka accounts for about 40 percent of all tea produced in Japan. Refined tea also accounts for about 60 percent. In an effort to contribute to one of Shizuoka's best known industries, the University of Shizuoka continues to conduct a university-wide range of studies on tea, covering such topics as the functional properties of tea, its potential to slow aging and prevent illness, and topics such as sales strategies and product development.

Slide 1: International exchange

The University of Shizuoka has cooperative arrangements with a number of universities throughout the world, and is actively engaged in collaborative research, academic exchanges, and exchange student programs with these overseas institutions.

Inter-university Agreements

- California State University, Sacramento — United States
- Roger Williams University — United States
- Mahidol University — Thailand
- Free University of Brussels — Belgium
- University of California, Davis — United States
- Bremen University of Applied Sciences — Germany
- University of Nebraska, Lincoln — United States
- University of California, Berkeley — United States
- The Ohio State University — United States
- Khon Kaen University — Thailand
- Yonsei University — South Korea

- Bogazici University — Turkey
- Lille Institute of Political Studies — France
- Griffith University — Australia
- The University of Arizona — United States
- Newcastle University — United Kingdom
- Zhejiang Academy of Medical Sciences — China
- University of the Philippines — Philippines
- Moscow State Institute of International Relations — Russia
- California State University, Northridge — United States
- Zhejiang University (formerly Hangzhou University) — China

Inter-departmental Agreements

- Rajshahi University — Bangladesh
- New Zealand Institute for Crop & Food Research (formerly Horticulture and Food Research Institute of New Zealand)
- Hue University — Vietnam
- Chulalongkorn University — Thailand
- Mahidol University — Thailand
- Zhejiang University — China
- Khon Kaen University — Thailand

- Seoul National University — South Korea
- Massey University — New Zealand
- California State University, Sacramento — United States
- Riddet Institute — New Zealand
- Dongseo University — South Korea
- Foreign Policy Association of the Republic of Moldova — Moldova

Language Study Abroad Programs

- Roger Williams University — United States
- California State University, Sacramento — United States

- The Ohio State University — United States
- Zhejiang University — China

(Apr.1,2015)
Listed in order of establishment, in reverse chronological order.

Slide 2: Tea Science Center

The Tea Science Center will facilitate the promotion of research and education related to tea at the university, and also aims to advance the understanding of tea production technologies and the health benefits of tea, not only in Japan but throughout the world.

1. Studies on the health benefits and epidemiology of green tea
We study the relationship between tea consumption and various illnesses, as well as the scientific functionality of green tea, which has been found to extend healthy life span, and application to the skin, etc.

2. Sharing our excellence in research and information about tea
We promote the tea industry by offering lessons or teaching seminars, and also making the information. We have acquired about tea available to interested parties.

3. Marketing to promote tea consumption
We seek to understand both tea quality and consumers' taste characteristics, in order to best determine a suitable and effective marketing strategy.

Slide 3: Tea Science Center

At the Tea Science Center, we teach about the health benefits of tea and pass on our knowledge about the best methods of cultivation, processing and marketing the various types of teas. The Center also collaborates extensively with other laboratories and organizations related to the tea industry

Slide 4: Spreading Japanese Tea Abroad

Slide 5: Characteristics of Tea

Tea have different chemical components from other plants
- ☆ Caffeine
- ☆ Catechins of Gallate type
- ☆ Theanine (Free Amino Acid)
- ☆ Others (Fluorine, Aluminum etc.)

Slide 6: World Tea Production

Green tea production is on the rise, as it has high functionality

Tea production by country & cultivation area (2013)

Shift in no. of research papers on catechin (Google Scholar)

Green Tea Drinking Abroad

Japanese tea is considered an item of high taste across the world, from cultural and functional aspects

Used courtesy of Mr. Tanimoto

Ex. of sale in U.S.

Why is Green Tea Loved Around the World?

① Psychotropic Use (warms heart, is a narcotic)
   Energy drink, cool/exciting, stimulant grass

② Functional Use (initially recognized as medicinal plant)
   Shennong Ben Cao Jing (ancient Chinese book on medicinal plants), *Kissa Yojoki*, tea wars, etc.

③ Cultural Drink
   Mystery of the Orient, *Book of Tea* (by Okakura Tenshin), Cha-no-Yu, Tea Culture

④ Abundantly Fragrant, Delicious Drink

⑤ Has a Multitude of Possible Variations

⑥ Others
   Colonial strategy, relation with alcohol

Characteristics of Japanese Green Tea

Steamed green tea
Parched green tea
Semi fermented tea

Vitamin C (mg/100g)
Gyokuro
Matcha
Sencha
Oolog tea
Black tea

Fig.4. Gaschromatograms of steamed green tea, parched green tea and semifermented tea made from fresh leaves plucked on the same day. (Tadakazu TAKEO etc. 1985)

· Color of poured tea is green
· Components are quickly eluted for steam method tea
· Amino acid content is high, catechin small amount of high amino acid content
· Aroma have freshly grassy flavor
· Shape is needle-like with firmly twist
· The content of vitamin C is high
· Japanese green tea has a long history and high cultural aspect

Main Export Destinations for Japanese Tea (FY2013)

Germany 140t $7.3 million

Canada 188t $2.9 million

France 56t $1.4 million

Taiwan 365t $4 million

America 1406t $28.5 million

Holland 29t $950,000

Hong Kong 78t $2 million

Thailand 131t $2 million

Malaysia 78t $1.2 million

Singapore 205t $5.8 million

The State of Japanese Tea Around the World

Production Volume
About 1.5 million t
Japan About 80,000 t

Export Volume
About 330,000t
Japan About 0.35t

Teabag
Japan
Matcha
China
Sencha

Production   Export

北米(n=85)   アジア(n=117)   EU他(n=214)

World Green Tea Production & Export Volume

Consumption of Japanese Tea Overseas

Tea Drinking in the U.S.

Changes in consumption of tea in U.S.

The amount of tea consumed in the U.S. has sharply increased and the market expanded, with a visible shift from black tea, ice tea and tea bags to green tea.

Slide 1: Japanese Tea in the U.S.

Japanese Tea in the U.S.

Shift in countries from which U.S. imports green tea

	2009 ton	Ratio %	2013 ton	Ratio %
India	604	3.9	1036	4.6
China	8548	56.6	14234	63.2
(Price)			3.8ドル/kg	
Japan	1418	9.2	1700	7.5
(Price)			19.4ドル/kg	
Germany	1185	7.6	732	3.2
Brazil	314	2.0	508	2.3
Taiwan	375	2.4	426	1.9
Total	15236	99.1	22534	100.0

International tea committee

Most of the green tea in the U.S. is from China, with that from Japan stuck at 7.5%. Most of it is also drunk using tea bags, and is sold at high prices.

Trend search for powder tea

Slide 2: Functions of Green Tea

Functions of Green Tea

Slide 3: Different Characters of function of Japanese green tea

Different Characters of function of Japanese green tea

Standard set of Japanese green tea.

Primary Function	**Nutritional Function**	Vitamins	VitaminC, VitaminE, β Carotene,
		Minerals	Potassium, Posphorus, Zinc, Manganese etc
Secondary Function	**Sensory Function**	Taste	Theanine, Amino acid, Catechins, Caffeine etc
		Aroma	Terpene, Alcohol, Ester etc
		Color	Flavonol, Theaflavins, Chlorophyll
Tertiary Function	**Body Modulating Function**		Catechins, Flavonol, Caffeine, Vitamins, Amino acid, Minerals etc.
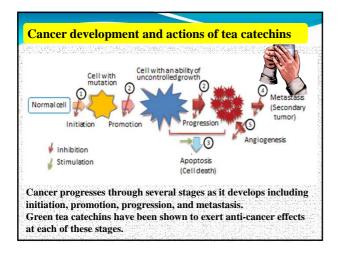
Slide 4: Physiological functions of green tea components

Physiological functions of green tea components

Green Tea Components	Contents	Functions
Catechins	10～18%	Anti-oxidative, radioprotective, Anti-mutagenic, Anti-tumor, Enzyme inhibitory, Anti-hypercholesterolemic, Anti-hyperglycemic, Fat reducing, Anti-hypertensive, Anti-ulcer, Anti-bacterial etc.
Caffeine	3～4%	Removal of fatigue, Sleepy feeling, Diuretic etc.
Vitamin C	150～250mg%	Removal of stress, Cold prevention
Vitamin B	1.4mg%	Excitometabolic action of carbohydrates and amino acids
Vitamin E	25～70mg%	Anti oxidative, Aging prevention
γ amino butyric acid	0.1～0.2%	Anti hypertensive
Flavonoids	0.6～0.7%	Halitosis prevention
Theanine	0.6～2%	Anti hypertensive

Slide 5: Can make the various types of tea from the same leaves

Can make the various types of tea from the same leaves

Tea leaves	Green tea		Black tea
Catechines	Catechines	⇒	Theaflavins, Thearubigins
Chlorophyll	Chlorophyll	⇒	Pheophytin
Vitamine C	Vitamine C	⇒	Nothing(Oxide, Hydrolyzate)
Aroma	Fresh, Grassy	⇒	like frowerly or fruity

Slide 6: Comparison of chemical contents of green tea and black tea infusion

Comparison of chemical contents of green tea and black tea infusion

The chemical contents of green tea and black tea infusion (Dry weight %)

	Green tea	Black tea
Total Catechin	30-42	3-10
Theaflavin	0	2- 6
Polyphenol	2	3
Flavonol	8	24
Theanine	3	3
Organic Acids	2	2
Caffeine	3-6	3-6
Vitamine C	4	0

Physiological functions of Japanese green tea components

Soluble components 35%
- First serving 13%
- Second serving 10%
- Third serving 7%
- Additional servings 5%

Insoluble components 65%

Insoluble crude fibers, Lipid, Chlorophyl, Carotene, Vitamin E, Protein, Others

Water soluble components

Catechins, Caffeine, Polysaccharide, Amino acids, Saponin, GABA, Vitamin C, Vitamin B, Fluoride, Others

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Various Functions Thanks to Catechin

- Antioxidant
- Antimutagen
- Cancer-fighting
- Oxidation resistant
- Anti-atherogenic
- Lowers blood cholesterol
- Lowers fat absorption
- Antibacterial, antivirus
- Prevents cavities
- Improves intestinal flora
- Eliminates odors
- Controls blood pressure
- Etc. Etc. Etc.

Crystals of tea catechins
EC EGC
ECg EGCg

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Cancer development and actions of tea catechins

Normal cell → Initiation → Cell with mutation → Promotion → Cell with an ability of uncontrolled growth → Progression → Angiogenesis → Metastasis (Secondary tumor)

Apoptosis (Cell death)

↓ Inhibition
↑ Stimulation

Cancer progresses through several stages as it develops including initiation, promotion, progression, and metastasis.
Green tea catechins have been shown to exert anti-cancer effects at each of these stages.

Epidemiological studies on correlation between green tea intake and the risk of human cancer

Study type	Cohort		Case-control	
	Risk reduction	No risk reduction	Risk reduction	No risk reduction
Colon	3	6	4	3
Lung	0	4	2	3
Stomach	2	6	8	8
Osophagus	0	2	4	5
Breast	3	5	3	0
Prostate	2	0	2	0
Ovaries	1	0	2	0
Pancreas	0	2	2	1
Kidney and bladder	0	1	1	4
liver	1	0	0	0
Endometrium	0	0	2	1
Thyroid	1	1	0	0
Blood	1	0	0	0

Cohort study: a group of similar individuals who differ with respect to certain factors under study to determine how these factors affect the rates of a certain outcome.

Case-control study: two existing groups differing in outcome are identified and compared on the basis of some supposed causal attribute.

Effects of catechins on weight and visceral fat area

<Weight>
- Regular green tea
- Green tea with a high content of tea catechins
**

<Visceral fat area>
- Regular green tea
- Green tea with a high content of tea catechins

Change from Baseline (kg) / Change from Baseline (cm²) vs Week

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Antidiabetic Effect from Catechin

Type-1 Diabetes: Insulin deficiency caused by destruction of beta cells in spleen, leading to high blood sugar and diabetes.

Type-2 Diabetes: While insulin is present, it has reduced secretion volume, and the intake function for glucose to muscles and fatty tissue drops (insulin resistivity expands). As a result, glucose in the blood is not stored as glycogen in the liver and fatty tissue, and glucose in the blood deviates from the normal range, causing high blood sugar levels and diabetes.

Catechin: Inhibits activation of amylase and glucosylase

通常の糖質吸収パターン / お茶による糖質吸収阻害パターン

Memory retention in mice ingested catechin

Senescence-accelerated mouse (SAMP10) shows memory decline with aging. As mice prefer a dark place, mice move into the dark box when placed in the light box. However, when mouse was given a weak electric shock through the floor of the dark box, mouse learned not to enter the dark room. Memory retention was tested one month later using same test. Memory decline was much suppressed in mice ingested green tea catechins than in control mice that ingested water.

Functionalities of theanine

- Reduces blood pressure
- Regulates cranial nerves performance
- Prevents vascular dementia
- Strengthens anti-tumor agents
- Improves cell infiltration resistance from lung cancer

Effect of theanine on mean blood pressure in normal and spontaneous hypertensive rats (SHR)
(H. Yokogoshi, et al. Biosci. Biotechnol. Biochem. 59, 615-618 (1995))

(Japanese Green Tea, 2001)

Graphic : Combined effect of DOX and theanine against liver metastasis in liver cancer mouse M5076 (score 0:normal ~5:above 75%)

Graphic : Increase in dopamine release resulting from administering dopamine injection in the

Effect of theanine on relaxation

Electroencephalographic measurement of alpha waves shows higher frequencies among human subjects taking theanine as compared to those taking water.

Effect of theanine on psychosocial stress

Shortened lifespan in stressed mice

Group and confrontational housing

After the two mice were housed separately, for one month, in a cage with a partition, they were housed confrontationally by removing the partition. Generally, group housing mice have long lifespan more than the stressed mice.

Prolonged lifespan of mice by theanine intake

Theanine is effective against stress and fosters life expectancy

Reduction of stress by theanine

Anti-stress effect of low-caffeine tea in human testing

Anti-stress and sleep-regulating properties of theanine

Epidemiological and animal studies have demonstrated that ingestion of green tea enhances healthy life [1].

The level of sAA in the morning was significantly lower when the participants ingested low-caffeine green tea than standard green tea ($p = 0.008$).

From Relief of Stress to Extension of Lifespan

Tea Development for the Elderly & Future Generations

☆ Improvements in Quality of Sleep
☆ Easing of Stress

Non-caffeinated tea steeped in cold water

Characteristics of sencha steeped in cold water
- Little bitterness & astringency
- Little elution of gallate-type catechin
- Little caffeine
- Strong sweet flavor
- High elution rate of amino acids

Strengthens immune system functions

Interaction of anti-stress effects of catechin, caffeine, theanine

Relationship Between Green Tea & Healthy Lifespan

Relationship between healthy lifespan and tea (Men)

Relationship between healthy lifespan and tea (Women)

Green Tea is Necessary for Ages to Come

Nutrient supply   Nutritional balance   Health/Mind

Happy

Food Product

Saves from starvation ⇒ Maintains/develops body ⇒ **Healthy**

Green Tea Makes Our Lives Better

If your throat is dry, drink water
If your heart is dry, drink green tea

We take supplements to boost our health, but will they make us happy?