研究論文

Study on Healthy Housing Using Recycled Organic Industrial Waste First Report: Overview of Trends in the Development of the Latest Technology and New Materials in Japan

KAMADA Kiyoko

再生有機産業用廃棄物建材を活用した『健康住宅』の実証研究 第１報：日本における最新材料・工法の開発傾向と成果の概要

鎌　田　清　子

1. INTRODUCTION

New health problems have emerged in conjunction with the world's aging population. Among them, suppressed immune systems, menopausal disorders, allergic diseases and other unconventional health problems closely related with conditions of the housing environment require solutions. However, developing measures to minimize household energy consumption and prevent wasteful uses of energy as a means to prevent global warming have been considered to be urgent tasks. In cold areas, technological developments and their dispersion for improving thermal insulation and airtightness (of houses) and constructing fuel-efficient, energy-saving houses, along with adoption of specifications that lower total construction costs, for example, are under way. Together with improved airtightness, the number of ventilation times has been discussed. If harmful chemical substances being emitted from building materials or laminated wood, in particular, and offensive odors due to long-term home care of elderly persons, waste and so on can be eliminated only by increasing the number of ventilation times, we would have to sacrifice room temperatures, as well.

This paper intends to report on and extensively discuss the effectiveness, evaluation and possible commercialization of proven natural materials and mechanisms based on ideas different from those of the conventional solutions, such as forced ventilation, the use of chemicals and adsorption methods, as well as explore the possibility of joint research.

2. RESEARCH METHODS

New ideas and methods that were independently researched and developed in Japan and have been commercialized and distributed in many fields are taken up for a comparative review here.

2-1. EM Bacteria (Effective Microorganisms)

EM is an effective microbial community that has assembled microorganisms that can benefit human beings and exist in the natural world. The concept of EM was developed by Dr. Teruo Higa, a professor at the University of the Ryukyus Faculty of Agriculture in Okinawa. Many EM bacterial strains are the same as the strains used in fermented food products, such as Japanese sake, miso (soybean paste), natto (fermented soybeans), vegetables pickled in salted rice-bran paste and cheese.

1. Practical Application Methods of Effective Microorganisms

With regard to the workings of effective microorganisms, antioxidants generated by microorganisms activate animal and plant cells and detoxify hazardous materials. As a result, effective microorganisms not only prevent excessive oxidation and energy consumption, but also possess the power to coexist and act with other effective microorganisms.

EM strains consisting of 80 types of effective microorganisms that meet the aforementioned conditions can be roughly divided into five groups.

1) Photosynthetic bacterial community: With light and heat received by soil as the energy sources, the phytosynthetic bacterial community feeds on secretions from plant roots, hazardous gases and hydrogen sulphide and biosynthesizes useful substances that support the growth of plants, such as amino acids, nucleic acids, physiologically active substances and saccharides.
2) Yeast community: Capitalizing on its fermentative power, the yeast community biosynthesizes substances useful for plants by using secretions from plant roots, amino acids, saccharides and organic matter in soil. Hormones and physiologically active substances generated by yeast activate root cell division.
3) Lactic acid bacterial community: The lactic acid bacterial community generates lactic acid by using saccharide released from photosynthetic bacteria and yeasts as the substrate (feed). Lactic acid is a powerful germicide and thus has the important functions of suppressing the propagation of harmful bacteria, in particular, as well as putrefaction/decomposition and accelerating fermentation/decomposition.
4) Fermentation-system filamentous fungus community: Among filamentous fungi, aspergillus, which is used to ferment alcohol, is most frequently used. Since it is a powerful alcohol-generating agent, it prevents increasing in worms and other harmful insects, and accelerates the decomposition of things that may be the cause of offensive odors.
5) Gram-positive ray fungus community: Ray fungi are somewhat in between cells and mold. They generate antibacterial substances while feeding on amino acids generated by phytosynthetic bacteria. The antibacterial substances suppress pathogens and substances that prevent harmful molds and bacteria from propagating (chitinous substances) create livable environments for other effective microorganisms.

Currently, the information regarding EM strains is available to the public in Japan, and grass-roots movements have been organized that promote their utilization methods and various types of product development. Experiments to verify their effectiveness

and commercialization have been under way in numerous fields, such as agriculture, the livestock industry, food processing and sanitary control in the living environment. The most advanced fields in terms of EM's commercialization are agriculture and the livestock industry, in which they activate soil and provide for abundant seed setting. Since they are powerful antioxidants, they can improve the immune systems of people, pets and plants, and prevent deteriorations and illness. They also contribute to solving global problems by decomposing water contaminates and harmful bacteria in drain outlets, rivers, lakes and seas with their power of decomposing pollutants.

2. Example of How to Make and Use EM Strains

EM fermentation liquid with water used for washing rice (reuse of rice food waste)

Among numerous methods available, this paper introduces a relatively easy method.

Materials:

PET bottle 1, 5-2 L
Funnel
Cup
Bowl
Hot water
Water used for washing rice (waste liquid)
Molasses or sugar: 20 - 49 cc
EM-1 or EMW strains: 20 - 40 cc

Procedures:

1. Pour a small amount of hot water into the cup and then molasses or sugar. Make sure that the molasses and sugar are dissolved.
2. Put the contents of the cup and EM in the bowl containing water used for washing rice, and mix them. When artificial sugar is used, replenish minerals by adding natural salt. It is important to thoroughly wash the containers to be used in order to prevent the appearance of unwanted bacteria. Never use the PET bottles and containers that have previously been used in an unsuccessful preparation process of EM fermentation liquid.
3. Pour the contents of the bowl into the PET bottle (up to the eight-tenth full) and firmly tighten the cap.
4. Let the contents ferment in a warm place with a temperature between 20 and 40_C.
5. When the PET bottle has bulged after two to three days, degas the bottle repeatedly to prevent implosion. Be careful not to let the contents spill over when degassing.
6. When it smells sweet and sour, the process has been completed. It takes approximately one week in summer and about two weeks in winter.
7. A beneficial fermentation liquid with water used for washing rice improves bacterial density and further accelerates fermentation when approximately 10% is mixed.
8. It is intended that the completed solution's pH should be 3.5 or below. It would be preferable for you to confirm this with litmus paper, for example.
   The entire solution should be used within two weeks; before offensive odors are emitted.

Specific utilization methods

Although EM strains can be developed according to various methods, products manufactured with high-quality materials are used for human consumption as soft drinks, and eliminate odors from the body, feces and intestinal gases.

Table 1 indicates utilization methods for an approximately 100-fold dilution, i.e. activator liquid (fermentation liquid) in household spaces and other places.

There are also various other EM strains utilizing biological waste and other EM-strain application products.

Table 1 Utilization methods of EM strains by room types and architectural places

Living space	Target	Dilution magnification	Amount of use	Remarks
Kitchen	Gas ovens and microwave ovens, sink, ventilation fan Carpet, tatami mat	50 – 100 fold 100 fold	Appropriate amount daily To the extent that the targeted area is slightly wet	For grease and offensive odors, spray 50-time diluted solution. Rooms and corridors where numerous people come and go
Room	Closet, curtain, carpet, chest of drawers, futon, bed, air conditioner		Spray weekly	Dust, cigarette smell, paper screen, sliding door, lighting fixtures Effective for making the air clean and preventing mites and harmful insect bacteria
Corridor	Wooden floor	100 fold	Appropriate amount as needed	
Toilet	Within the toilet Toilet	100 fold	Appropriate amount as needed	Clean the toilet and the inside of the toilet by spraying diluted solution. They become resistant to stains and have deodorizing effects.
Bathroom Floor grates Floor, wall	Bathroom drain, bathtub	50 – 100 fold 100-fold dilution	Appropriate amount as needed	Bathroom ditch, fittings, floor plate, pail, etc. in the bathroom Spray diluted solution. It will prevent the development of slime, stains, odors and mold.
Garden	Trees, flowers, vegetables	1000 fold	Appropriate amount while watering plants	Spray to plant pots and trees in the garden. Plants grow well when 1000-time diluted solution is sprayed.
Other Cat/dog, inside car	Shoe cupboard, pets	100 fold	Spray appropriate amount as needed.	When 100-fold dilution is sprayed directly on dogs or cats, offensive animal odors will be eliminated. The animal's coat of fur will also improve.
Indoor/outdoor swimming pool				Purification of water

Washing: For washing, use half of the typical amount of commercially available synthetic detergent and mix 20 ml of EM per 40 liters of water. You can eliminate stains more effectively if you soak laundry overnight in this solution. The wastewater produced by washing will also contribute to purifying polluted sewage water environment.

Unintentional dyeing of clothes and appliances can be prevented using the appropriate EM strains.

2-2. Mechanism of Antioxidant Effects by SOD Liquid Method

SOD liquid is made from fossils of zooplankton and phytoplankton by dissolving them in water that contains well-balanced oceanic minerals in the form of crystal dust. Far-infrared electromagnetic waves (in the range of 6 - 14 microns) react with moisture in the air and generate large amounts of negative ions, suppress positive ions and the negative ions decompose toxic chemicals.

Negative ions (hydroxyl negative ions) that continue

to be generated indoors are expected to not only decompose toxic chemicals, but also have deodorizing effects on offensive odors of pets, cooking smells, odors due to home nursing care and so on.

Since the details of SOD liquid, which is created by turning far-infrared radiation substances into an aqueous solution, using nanotechnology, is patent-protected, this paper does not delve into them and, instead, sheds light on achievements with the liquid and its use's confirmed improvement in the condition of patients suffering from sick house syndrome.

This paper reports the representative application examples and air quality measurement results before and after application.

Application Example (A): Ordinary wooden frame house located in Shinkawa, Sapporo (N34, E28, Higashi-ku, Sapporo)

At an ordinary wooden house built in accordance with Japan's thermal insulation and airtightness improvement method, experts at the Hokkaido Institute of Public Health measured the air quality and chronologically followed up on the measured values three times in total - on October 6, 2003 (before application), October 16 and 24, 2003 (after application).

Method of measurements: Ventilation other than forced ventilation was stopped for five hours prior to measurement. All openings, e.g. windows and doors in contact with the open air, were closed.

Method for taking air samples: Conditions for measuring the concentration of formaldehyde and acetaldehyde

Method for taking air samples: active sampling (1 L/min), using PEJ-02 tube, trapping for 30 minutes

Method of quantification: high performance liquid chromatograph

Volatile organic compounds (toluene, xylene, ethylbenzene, paradichlorobenzene

Method for trapping air: active sampling (20 mL/min), using PEJ-02 tube, trapping for 30 minutes

Method of quantification: thermal desorption - gas chromatography mass spectroscopy

Photographs of measurement conditions

1F living room

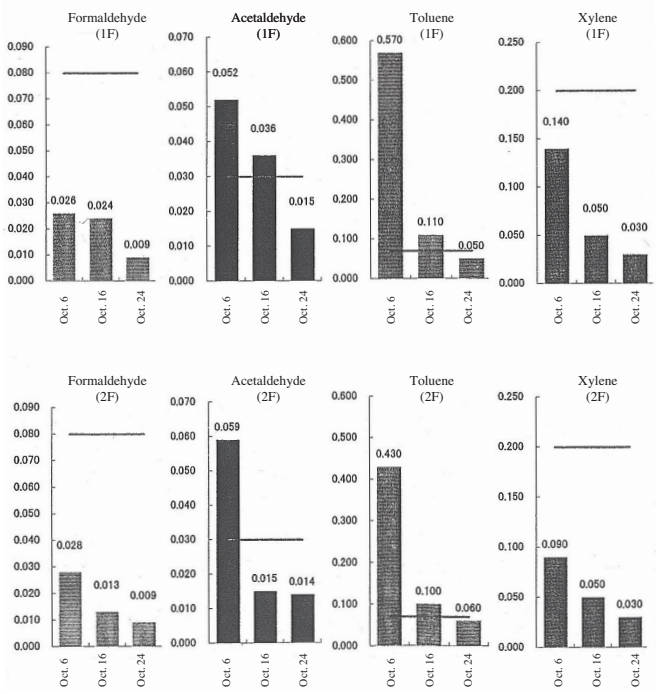
2F Western-style room

Comparative examination of measurement results and the guideline values

Weather conditions at the time of measurements

Date of measurement	Time of measurement	Room temp. (1F)	(2F)	Humidity (1F)	(2F)
October 6, 2003	14:09- 14:41	24.3	24.2	48%	43%
October 16, 2003	14:03-14:37	24.1	23.3	38%	38%
October 24, 2003	14:35-15:40	19.2	19.0	33%	37%

Measured values of each chemical component



Application Example (B): Measurement of environmental improvements in Sumikawa District Center, Urban Renewal & Development Bureau, Sapporo Municipal Government

Two employees working in this public building were suffering from sick house syndrome. Upon the request of the city government, SOL liquid was sprayed throughout the building on July 9, 2002. After the application, indoor air samples were measured several times and the level of the concentration of chemical substances was examined by conducting follow-up measurement.

(1) Method of measurements

All openings other than forced ventilation were closed.

Date of measurement	Time of measurement	Room temperature	Humidity
07/09/2002	10:40-11:50	24	65%
07/10/2002	09:45-11:30	23	64%
08/03/2002	09:30-11:30	27	59%
09/02/2004	08:05-08:50	25	62%
09/12/2004	14:00-14:40	26	40%

(2) Method for taking air samples

Air sampler -S21 (manufactured by Komyo Rikagaku Kyogyo K.K.) was used.

(3) Method of measuring concentration

The detector tube method was used to measure the concentration of chemical substances.

Formaldehyde: detector tube 710 (300 mL/30 min.) manufactured by Komyo Rikagaku Kyogyo

Toluene: detector tube 720 (200 mL/20 min.) manufactured by Komyo Rikagaku Kyogyo

Paradichlorobenzene: detector tube 730 (200 mL/15 min.) manufactured by Komyo Rikagaku Kyogyo

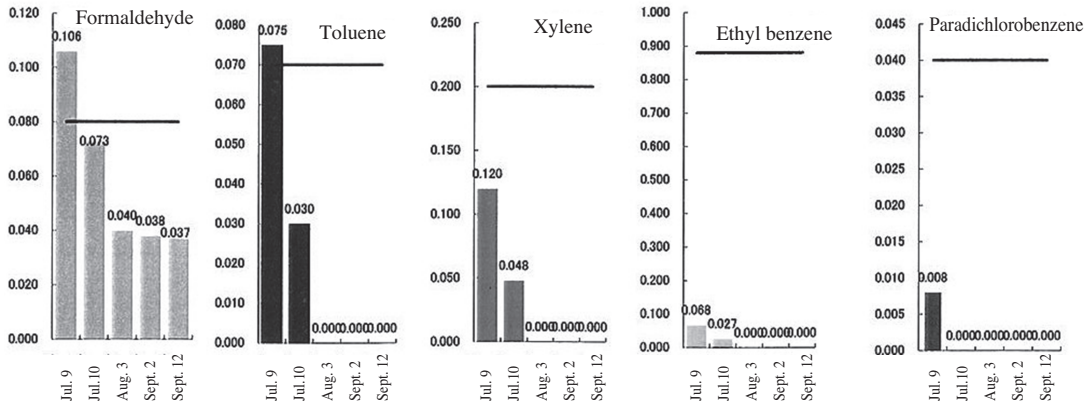
(4) Method for converting concentration units

With the detector tubes used in this study, concentration is expressed in ppm, which can be converted to μg/m3 using the following equation:

ppm × M/22.4 × 273/(273 + t) × hpa/1013 × 1000 = μg/m3

(5) Comparison between measurement results and guideline values for indoor concentrations of chemical substances stipulated by the Ministry of Health, Labour and Welfare of Japan

Measurement results at a Sumikawa Commuity Center meeting room



* The minimum value (0) indicates concentrations of chemical substances that are less than the lower limit of detection.
Evaluation: Concentrations of chemical substances after treatment are maintained below the guideline standards of the Ministry of Health, Labour and Welfare.

C. Application Example (C): Construction of a school for the physically and mentally challenged in Hassamu, Sapporo (Hassamu 11-jo 6-chome, Nishi-ku, Sapporo)

In the construction of a school, various cabinets, furniture and fixtures are needed to organize books, school equipment and study materials for students. As a fixture material for general use, laminated plywood with a thickness between 12 and 24 mm is used. For this reason, the more recently a nursery, kindergarten, school or hospital has been built, the higher the concentrations of chemical substances is. Since this is a school where children with physical and mental disabilities spend much of the day, it is particularly necessary to lower the indoor concentrations of chemical substances.

Procedure for applying the antioxidation process using far-infrared ray

1. Heat "Antioxidant Liquid" to 50_C and apply it to walls, ceilings, floors and surface of indoor furniture and fixtures at a rate of 50 cc/m2 or more.
2. After the application of "Antioxidant Liquid," heat "SOD Far-infrared Ray Antioxidant Liquid CLEAR" to 50_C and apply it to walls, ceilings and floors at a rate of 50cc/m2 or more.

3. After the application of "CLEAR," open the windows to let it dry naturally.
   Apply two coats of "Negative-ion Wax" agent to the floors.
4. The work is completed when it dries naturally.

(1) Method of measurements

The first measurement was conducted between 10:04 and 11:45 on March 2, 2004, and the second measurement was conducted between 13:33 and 14:03 on March 10, 2004 by the Hokkaido Institute of Public Health, a public organization responsible for taking such measurements. Along with research results, room temperature and humidity are shown.

(2) Method for taking air samples

Conditions for measuring the concentration of formaldehyde and acetaldehyde

Method for trapping air: active sampling (20 mL/min), using DNPH cartridge, trapping for 30 minutes

Method for quantification: high performance liquid chromatograph

Conditions for measuring volatile organic compounds (toluene, xylene, styrene, ethylbenzene, paradichlorobenzene)

Method for trapping air: active sampling (20 mL/min), using PEJ-02 tube, trapping for 30 minutes

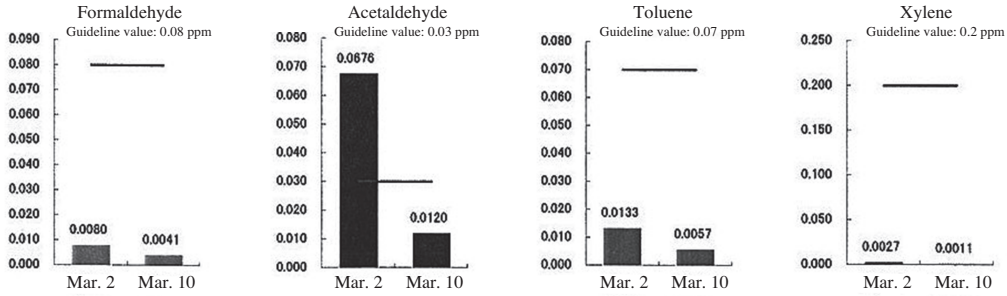
Method for quantification: thermal desorption - gas chromatograph mass spectrometry

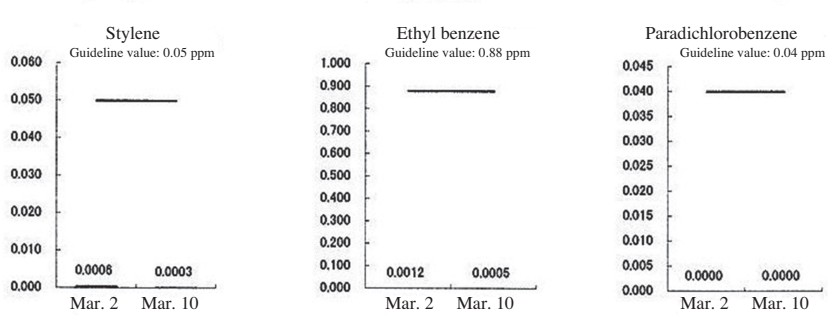
(3) Comparison between measurement results and guideline values for 13 items stipulated by the Japanese Government

The first measurement results obtained on March 4, 2004 and the second ones 8 days later on March 14, 2004 were compared with corresponding guideline values.

The second measurement results for formaldehyde, acetaldehyde, toluene, xylene and other substances obtained in the faculty room showed a remarkable decline.

Measurement results at the construction site of the new Hassamu District School for the Disabled





Evaluation: Concentrations of chemical substances after treatment are maintained below guideline standards.

2-3. Examination of Effects of Processing and Application of Natural Materials as Interior Goods

1) Kumasasa cloths

"Kumasasa" is a plant that grows in fields and mountains of cold areas and is used to produce bamboo materials. Wild bears eat large amounts of Kumasasa before hibernating because it detoxifies the body during hibernation. It is highly antibacterial and fights E. coli bacteria and methicillin-resistant Staphylococcus aureus (M-RSA), believed to be the cause of in-hospital infection. In Japan, it has long been handed down through oral traditions as a healthy, active ingredient of herbal medicine, and for various types of processed food products, fabrics and clothes and many other fields as one of the empirical rules. Light is shed on absorption and decomposition properties of "Kumasasa cloth," which was recently developed and commodified for in-home use for those who are sensitive to chemicals or suffer from sick house syndrome.

"Sasawashi Curtain" is breathing. It purifies the air and absorbs the odors with its natural power and keeps the room clean.

Kumasasa, the raw material of "Sasawashi Curtain" grows only in and around Japan. Its natural power has been woven and preserved in "Sasawashi Products," which brings us back the ancient lifestyle of Japan. "Sasawashi Curtain" blocks the harmful ultraviolet rays. It also absorbs and dissolves minute harmful elements and adjusts the moisture in the room, thus naturally produces negative ions. Moreover, the soft lights penetrating through "Sasawashi Curtain" relax many people's hearts.

Natural Mechanism of Durable "Sasawashi Curtain" Naturally Adjusts the Moisture and Keeps the Room Clean

"Sasawashi Curtain" prevents the producing of condensation on walls and windows. Since Sasawashi fabric has enough space between its molecules, it absorbs the moisture when humidity is high, and emits the moisture when the air is dry. The natural adjustment power of Sasawashi creates the environment where less condensation is produced in the room. So the room is always kept clean and hygienic with hardly any mold or ticks forming. Sasawashi also has been proven to absorb odors, dust, and pollen and harmful elements which are the major cause of atopy. The breathing "Sasawashi Curtain"purifies the air and naturally adjusts the moisture.

Washable Washi

The Sasawashi fabric was tested after having been water-washed and dry-cleaned more than thirty times and proven to preserve the initial function. The post-processed "natural" products considerably lose its function as time goes by; however, the performance of Sasawashi fabric is intensified after many washes decreasing the number of bacteria.

Amazing Natural Antibacterial and Deodorant Effects

Bears eat a lot of Kumasasa before hibernation to detoxify the poison in the body. This detoxification effects are preserved in "Sasawashi Curtain" and work against colon bacilli and MRSA, the cause of in-hospital infection. These natural antibacterial and deodorant effects are preserved even after the fire proofing process, thanks to our recent technology.

Blocks Ultraviolet Rays

"Sasawashi Curtain" blocks more than 95% of all A, B and C Ultraviolet rays.

Produces Negative Ions

Negative ions, which relax and calm people's feelings, are produced where moisture, wind and the sun work together. Much more negative ions are produced where the moisture is taken in and out of things. "Sasawashi Curtain" always adjusts the moisture and actually produces negative ions as the tiny water molecules go in and out of the curtain. Thus, the cleanliness of Japanese houses using a lot of Washi is supported by the fact that Washi actually produces negative ions and keeps the people's life healthy and comfortable.

All the substances in this world have their own undulation. Our cells respond positively to the good undulation. Satisfied cells highly activate the immune system and improve the blood circulation of the body. The more exposed we are to the substances of good undulation, the more satisfied our body cells are: we become healthier and the comfortable life continues. With the improvement of health, one can experience fresh feelings. "Sasawashi fabric" is proven to have the natural healthy power according to the various scientific data, but beyond the measurable data, it holds the great healing power of nature. The environment of the room is very important for people's health.

2) Adsorption and Deodorizing Effects of Charcoal, Bamboo Charcoal and Wood Vinegar

In Japan, the construction method referred to as "charcoal burial" has been in use for more than 2,000 years in which charcoal is buried deep underground below the tombs of the nobility, temples, castles and houses. This is because far-infrared rays released by charcoal and bamboo charcoal are effective for preventing the spread of decay bacteria and the decay of timber.

In recent years, carbonized materials have been used in the development of products related with food, clothing and shelter as well as the living environment due to people's health-oriented mindset in Japan. This report examines the effectiveness of such interior materials against toxic chemicals.

2-4. Health Benefits of Marine Waste Such As Scallop and Oyster Shells

Every year, 210,000 tons of more shells are disposed as waste mainly in the Tohoku and Hokkaido regions in Japan. After the enforcement of the Law Concerning the Recycling of Industrial Waste, there is no choice but to effectively use or reuse waste. It was verified that ceramics made using burned scallop shells had the effect of contributing to reduction and decomposition of chemical substances, disinfection, odor elimination and repelling insects. Joint research between universities and corporations on the practical application of oyster shells is in progress and the following applications were confirmed as being useful:

1) Plaster wall, paint, paper and textile products as a measure against sick house syndrome
2) Disinfectant and deodorant for use in kitchen
3) Deodorant for shoes and disinfectant for athlete's foot fungus
4) Non-woven sheet containing ceramics
5) Health benefits as calcium pills

Particularly notable among them is athlete's foot remedy MOIYA ("no more athlete's foot"), which was developed based on a discovery by workers at a shell burning factory that persisting itch caused by athlete's foot stopped when they were working.

There are 340 million people who suffer from athlete's foot around the world and the market size for products designed to relieve its symptoms is estimated to be 1,120 billion yen. In the West, a number of people suffer from onychomycosis. Unfortunately, there have been reports of deaths due to hepatic function disorder caused by oral medicine intended to treat onychomycosis.

However, scallop shell-based treatments use pure and natural materials prepared by mixing shell ceramics in distilled water. In a clinical trial conducted in the U.S.A., 70% of the 20 test patients completely recovered within three weeks. This treatment was named "MOIYA" and will be marketed at an affordable price for the first time in the world starting in June 2006. Since the number of patients is rapidly growing among working women and people suffering from menopausal disorders, its benefits are widely anticipated.

3. RESULTS AND DISCUSSION

3-1. Effectiveness of EM Strains

The effectiveness of EM strains is apparent since products with various combinations of strains have been developed in a number of different fields. As the world's population ages, cases of home nursing care, keeping pets indoors, appreciating potted plants and so on have increased and solutions to bacteria, mite, mold, filth, feces odors and other problems that cannot be solved by mechanical ventilation alone have become indispensable. Nevertheless, there is a limited amount of research data that has verified the effectiveness of such methods numerically with measuring equipment, which is regarded as the scientific method. Evaluations based on sensory tests that have been conducted by numerous users and successful empirical examples have caused supporters of the effectiveness of EM strains to increase in number in various places.

3-2. Effectiveness of SOD Liquid

A construction company in Sapporo independently developed the technology for this liquid to be sprayed in architectural spaces (floors, walls and ceilings), furniture, curtains and interior accessories, and measured and verified improvements in air quality after application. After the passage of relatively short time, apparent reduction of toxic chemicals was confirmed. Beneficial result were recorded particularly at schools, day-care centers for children, kindergartens, housing facilities for the elderly (equipped with medical facilities) and other places with significant amounts of plywood be used for their bookshelves and closets, and furniture and fittings for which concrete panels are processed. The density of toxic chemicals tends to be high in Japan even when the guideline values stipulated by the Japanese Government have been met. SOD liquid technology is expected to be popularized as a method for purifying the air in rooms where the elderly with weakened immune systems, middle-aged and elderly persons suffering from menopausal disorders, and babies and infants with atopic disorders and/or allergic symptoms live. The following photos show a boy before and after improvements in his allergic condition.

3-3. Effectiveness of Natural Components in Improving Air Quality

3-3-1. Effectiveness of Kumasasa

Since Kumasasa leaves contain a medical property called xylo-oligosaccharide, Kumasasa's antioxidant effects, which enable the blood to circulate more smoothly in the body and improve oxidation, have been acknowledged and used in supplements and health food. In addition, it is a particularly strong germicide that it has been conventionally used in wrapping rice balls and sushi to prevent food poisoning and is also being laid at the bottom of containers of "Izushi" (fermented rice with fish, vegetables and rice malt) in which fish prone to bacterial propagation is pickled. There is no objection to the idea of using this germicide to improve the air of the living environment. However, again, there is a significant challenge: there are few methods available to scientifically prove its effects in improving human health. It is therefore necessary not only to remove toxic chemicals, but also to establish medical and physiological test methods to prove antioxidant effects on the human body and blood.

3-3-2. Effectiveness of Charcoal, Bamboo Charcoal, Rice Hull Charcoal and Wood Vinegar

Having been used extensively with food, clothing and structures for a long time, charcoal has been a familiar material with Japanese people. The porous property of charcoal adsorbs chemicals and far-infrared rays are effective for suppressing the propagation of decay fungi.

As for food, it has been empirically acknowledged that confectioneries, including Japanese rice cakes, have detoxification effects, even alleviating pregnant women's morning sickness, and is effective for activating intestinal bacteria. To cite a few examples, wood vinegar is used against Trichophyton and other types of dermatoses, as a bath agent to make skin beautiful and for pest control in organic agriculture.

In the field of housing and construction, the "charcoal burial" method is well established. In wooden architecture, when temples, castles, ancient tombs for noble people and public structures that are intended to be durable and long-lasting are constructed, charcoal is buried deep below the underpart of the foundation. The foundation, pillars and beams of wooden structures are then built above the buried charcoal. Underground far-infrared rays are expected to obstruct decay bacteria and harmful insects in the ground. As for improvements in air quality in response to sick house syndrome, housing construction specifications emphasizing the use of charcoal have also been developed. There are actual cases where using charcoal by mixing it in under floor, ceiling and intra-wall thermal insulation materials, for example, helped promote blood flow and regenerate hair.

In Asia, where rice is the staple food, large amounts of rice hull have been discarded as agricultural waste.

It has been discovered that industrial waste, which is generated in large amounts every year, could be recycled into the living environment and used as housing construction materials by carbonizing it.

In results of component measurement and analysis of the air that changed before and after application, data regarding measured values of some chemicals are available.

3-3-3. Health Benefits and Recycling Method of Marine Waste Such As Scallop and Oyster Shells

Large quantities of shell waste are generated by the fisheries industry, which is one of local industries, and the resulting environmental pollution has posed a significant challenge. Scallop shells are burned, ground and mixed into cement powder for fishing banks, which are submerged in the ocean. Shell lime decomposes chemical pollutants in the seawater. Conventionally,

ground burial is the only way of disposing of shell waste. Recently, an effective component that functions as an antiseptic was extracted from scallop shells and its practical use has been just started in Japan. It was confirmed that shell ceramics that were burnt at a low temperature of 400_C had effects of 1) decomposing chemical substances, 2) acting as an antimicrobial, 3) eliminating odor, 4) repelling insects, 5) preventing electromagnetic waves and more. Among them, the antimicrobial action, in particular, is used in shoe deodorants and athlete's foot fungus treatment, and the athlete's foot remedy "MOIYA" will be placed on the U.S market in June 2006. This is a natural material prepared simply by dissolving scallop shell powder in distilled water and it has no adverse effects. Nevertheless, it was confirmed that its cure rate is several times higher than that of LAMISIL. And above all, the price is lower.

Table 2. Results of antifungal characteristics test

(Number of fungus colonies: CFU/mL, room temperature, 1 hr., shaking, supernatant solution - 3 weeks)

Test samples	1 hour	1 day	1 week	3 weeks
Shell powder (burned at 400ºC)	1.25×10^3	2.26×10^4	2.00×10^4	1.89×10^5
Calcium hydroxide ($CaOH_2$)	7×10^2	5×10^2	1.60×10^3	6×10^2
Scallop plaster wall material (Pigment added)	2.5×10^2	5×10^2	4×10^2	4×10^2
Extracted fruit juice (Kiwi)	3.70×10^4	2.00×10^4	2.96×10^4	1.28×10^5

Furthermore, by focusing on the antibiotic and insect repellent effects of shells, techniques for processing biodegradable foam into pellets using cornstarch as a main ingredient into which shell micro-powder is mixed have been developed. It can be used for various purposes including bedding for home nursing care and nursing care in general, huggable pillows, mattresses, anti-bedsore mattresses, cushions, and filler for staffed animals, pet litter, and sandboxes for children. It has biodegrading characteristics and contributes to soil improvement and global environmental protection after its disposal. There are some measurements of far-infrared ray from bedding.

Table 3. pH* of test samples and electrification [EC(S/m)]**

Test samples	pH	EC (S/m)
Scallop plaster wall material (pigment added)	12.6	0.73
Natural slacked lime	12.7	0.75
Slacked lime (reagent)	12.6	0.74
Scallop powder (burned at 400ºC)	9.24	0.018

* pH measurement (reagent: H2O = 1:2.5 [weight ratio])
** EC measurement (reagent: H2O = 1:1.5 [weight ratio])

Recently, the number of patients using medical devices and artificial organs, such as cardiac pacemakers, is increasing rapidly across the world. Meanwhile, electronic devices such as computers, cookers, microwave ovens and cellular phones are everywhere. Measures to lower indoor electron concentration are indispensable. Table 3 shows that the electrical conductivity of scallop shell powder is extremely low. It is expected that a technique for spraying or applying a solution similar to SOD liquid has the effect of reducing electromagnetic

wave levels. With respect to other applications, mats and shoe soles made by mixing surf clam shell particles into used rubber tire and waste rubber chips were developed. Their resiliency and increased traction make them effective in reducing slippage at entrances and exits and on icy winter roads. In cases where persons in wheelchairs or elderly persons may fall, the effect of easing the severity of serious injuries and bone fractures can be expected.

In the future, applications such as those of fine aggregates to be used in the foundation of houses, a material for wet plaster wall, paving blocks for gardening, pet litter and sandboxes for children will be feasible.

4. FUTURE CHALLENGES

4-1. Challenges Facing EM Strains

EM strains are extremely effective for recycling raw garbage (animal and plant waste, food waste and trash) that is used as a mushroom bed to propagate effective bacteria. However, it is highly likely that harmful bacteria other than effective bacteria will be introduced into the mix during fermentation processes, making it difficult to maintain the expected effects under given conditions. EM strains that have been commodified are sold at high prices.

In agriculture and dairy farming, EM strains have no problems when used for agricultural waste treatment, livestock manure composting and soil improvement, and as a fertilizer for vegetables and fruit. They have been used in numerous livestock barns, including cattle barns, and poultry houses, which have strong excretory odors, and their deodorizing effects have been confirmed. These structures are often ventilated. In the future, verification will be required by conducting clinical tests in houses and architectural spaces where people live.

4-2. Challenges Confronting SOD Liquid

SOD liquid is a proprietary technology, so not everybody is at liberty to use it. Currently, franchising is under way and it is necessary to examine methods of proving changes in air quality before and after application as well as improved air quality after application. It is also necessary to extensively collect clinical examples of markedly improved medical conditions and symptoms by using this technology and accumulate examples of improvements for people suffering from respiratory diseases, dermatitis, unidentified symptoms and so on. Indispensable in this regard is the cooperation of persons to be tested in providing their clinical information before and after using the spaces subject to application. Accumulation of examples of cures and marked recoveries from illnesses as evidences is required for checking the correlation.

Since no harmful actions to man and animals are confirmed with the use of the SOD liquid method, it is effective for households with home nursing care and/or infants suffering from atopic dermatitis. Having said that, it will necessary to confirm the sustainability and continuity of the effects, track temporal intervals for reapplication and so on after the first application.

4-3. Challenges Facing Natural Plant Materials

4-3-1. Kumasasa

For technologies that use the natural plants growing in limited areas as raw materials, such as "Getto" in Okinawa Prefecture and "Kumasasa" in Tohoku and Hokkaido, it is impossible to continually extract large amounts of these raw materials. Depletion of resources due to overexploitation is also a concern. Therefore, the use of such materials will be limited to varieties that can be cultivated artificially. Mass production and price stabilization of natural plant materials are consequently difficult.

4-3-2. Charcoal, Bamboo Charcoal, Rice Hull Charcoal and Bamboo Vinegar

The Chinese Government has already banned charcoal production with the intention of protecting forest resources and the natural environment. Instead, charcoal made from bamboo, which has significant regenerative abilities, has been produced and supplied in large quantities. Although imported products from China are price competitive, the amounts imported vary depending on the international situation. In addition, with regard to the quality of bamboo vinegar, there are concerns about reliability regarding its germicidal potential. The problem is that there are no reliable sources supplying it nor quality standards. One ton of charcoal per house would result in a charcoal supply shortage. Therefore, charcoal production must be increased as fast as possible in China and other Asian countries.

4-3-3. Shells and Other Marine Wastes

Immeasurable amounts of materials that can be used in healthy products for the home are being disposed of as waste by marine processing plants throughout the world. However, the spread and standardization of these materials are highly likely to be hindered by expenses related to personnel and processing equipment for washing, drying, crushing, packing and transporting them. Attention has recently been paid to the weight loss effects of amino acid extracted from scallop shells and their other health benefits, including strong bactericidal activity against foot ringworm. In Japan, however, these materials and their effects are not widely known and their distribution volume is small. To reduce such costs, it is necessary to develop new distribution systems for these materials, including world-wide on-line shopping using IT technology, and promote home repair and other methods of use.

5. CONCLUSION

Natural materials, the decomposition of toxic chemicals by natural agents and the effects of controlling offensive plant and animal odors, mold, mites and other harmful insects and pests have been examined in this report. This report has shown that the effects are moderate compared with strong effects of chemicals. However, EM has little danger to people with their suppressed immune systems and natural healing abilities, people suffering form sick house syndrome and/or chemical hypersensitivity, infants and so on.

This is regarded as the wisdom of our predecessors; based on hundreds of years of experience as well as a method of realizing that indoor air that can be used for long periods of time without anxiety. In an age where dementia patients are rapidly increasing, alleviation of excretory and body odor is the key for sustainable care being provided by care-givers and family members to the patients. Inexpensive, safe measures are required.

6. REFERENCES

6-1. Research achievements about EM technology discovered by Dr. Teruo HIGA, A professor at the University of the Ryukyu Faculty of Agriculture.

6-2. Technical Development Concerning Effectiveness of Charcoal and Carbonized Materials against the Sick House Syndrome. By Kiyoko KAMADA. Takashi SASAKI.
Cold Climate 2006. The 5th International Conference on Cold Climate. Heating, Ventilation and Air-Conditioning. May21-24, 2006. Moscow, RUSSIA.

6-3. "A Study on the Effectiveness and Utility of Charcoal and Recycled Charcoal Materials in a Housing & Indoor Environment." By Kiyoko KAMADA, BULLETIN of HOKKAIDO

BUNKYO UNIVERSITY No.29. March 31, 2005.

6-4. "A Study Concerning with Effective Usage of Anti-Oxidative Material by Industrial Trash." By Kiyoko KAMADA.

BULLETIN of HOKKAIDO BUNKYO UNIVERSITY. No.30.March 31 2006

6-5. "Antibacterial Properties of Scallop Shells", By Masami KISHI, Takuya KUDO. Memoirs of Hokkaido Institute of Technology. No.29 (2001).

6-6. "Characterization of Plaster Material Making Use of Scallop shells". Memoirs of Hokkaido Institute of Technology. No34. March 2006. By Masami KISHI, Yukio KOMATSU.

6-7. "Bionic Design of the Scallop shell- Development of New Products Applying Its Functions" HACHINOHE Institute of Technology. Department of Chemical for Bio-Environment, Faculty of Engineering. Professor By Shinji KOYAMA et al. 2003. November.

6-8. Technical Development Data at Assist Riken Co., Ltd. (SAPPORO) By Masaru OKAMOTO. Daisuke OKAMAOTO.

6-9. Product Development Data at ITOI textile Co., Ltd. (OOSAKA) By Shohei ITOI & et al.

（2007年12月18日受稿）

Abstract

This report is intended to introduce and also explain the effectiveness of health promoting technologies that have been researched and developed in Japan, traditional lifestyles, and products and technologies that have been commercialized based on knowledge gained through experience. Among others, the use of scallop shells, a type of marine waste, in construction materials may contribute greatly to the conservation of the global environment by minimizing industrial waste and preventing the destruction of nature.

With Japan's aging population, an increasing number of people suffer from compromised immune systems, menopausal symptoms and unspecified ailments. In addition, the number of children suffering from allergies and atopic diseases has been on the rise due to heavy use of chemicals. The concentration of toxic chemicals contained in the air found in houses, day care centers, hospitals, infant facilities, schools, offices and other spaces where people spend significant amounts of long time is closely related with their health. This research sheds light on and considers the potential of outstanding technologies, products and ideas that utilize natural resources and are representative of Japan.

要　旨

本論文は2006年7月アメリカ合衆国　ニューオリンズ市内で開催されたAir & waste management Association（A&WMA'S99）99th Annual Conference & Exhibition で口頭発表したものである。

日本で開発した有機産業廃棄物を活用した『健康住宅』向け内装建築材料のアレルギー症状、アトピー性皮膚炎患者の健康回復プロセスと有効性の検証研究である。ハリケーンカトリーナ被害で倒壊家屋のカビや空気汚染に苦しむ被害者の復興に向けた技術支援として発表したものである。