# *Johrei*, a Japanese Healing Technique, Enhances the Growth of Sucrose Crystals

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The effect of *Johrei* treatment on the crystallization of sucrose from supersaturated solutions was studied in comparison with the crystallization in untreated solutions. This work was performed assuming that *Johrei* enhances the natural mechanisms of equilibrium restoration in biological and nonbiological systems. The crystallization in *Johrei*-treated solutions as judged by statistical analysis was found to be faster than the crystallization in untreated solutions. A discussion is presented about the mechanisms possibly involved.

**Key words:** Johrei, crystallization, healing, sucrose crystals

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## INTRODUCTION

A growing interest in methods of healing through the hands without touching as a potentially useful therapy has elicited an increasing number of reports on this subject,[1-16] including a description of a putative kind of energy or principle, called *Johrei*, created by Mokiti Okada during the early 20th century in Japan.[17-25] According to Okada, *Johrei* is essentially a method of spiritual purification attained by channeling the divine energy through the hand of the practitioner. The *Johrei* energy that comes about through this purification is said to be able to promote healing.

Research into this phenomenon demands a scientific approach based on experimental methodology, accompanied by an explanatory theory, to throw some light on the working mechanism by which it exerts its effects. Most papers about healing through the hands have a tendency to be descriptive in nature and limited to describing the effects on a human subject. There are also works involving nonhuman subjects, such as cell cultures, animals, and microorganisms,[5,9,16,20,21,25] in which many effects of the psychological structure of human subjects are absent, making the interpretation of the phenomena less complicated. However, even in the cases in which relatively simple living subjects were chosen, there are too few observations that could point to elucidation of a possible mechanism of interaction.

A noted absence exists of reliable control experiments in some reports. Furthermore, studies about methods of healing through the hands, applied to systems with well-known physical, chemical, and biological properties, are scarce. Nevertheless, the authors of the present report were induced to study *Johrei* on a scientific basis due to the continued spread of the technique of healing through the hands and the increasing number of people, with apparently reliable testimony, who report having received the benefits of this therapy.

In a first approach,[25] canary seeds irradiated with gamma radiation (from Cesium-137) were treated with *Johrei*, and germination data were compared with the germination data of irradiated seeds not treated with *Johrei*. This comparison, rigorously analyzed through statistical methods, clearly indicated an effect. Because the experimental model was created to be as free of the placebo effect as possible with human subjects, this "healing" effect deserves closer investigation. Based on a critical study of the results obtained from this first work, a hypothesis was proposed in which *Johrei* acts by enhancing the efficacy of cellular restoration mechanisms, thus contributing also to the process of biological organization.

The biological organization as here considered takes into account that biological processes, in general and, more specifically, the ontogenetic processes, follow strictly determined spatial and temporal programs, morphogenesis being one clear example of these programs.[26] Regarding biological processes that result in changes in a general state of spatial organization, a comparison with other physical and chemical organization processes (eg, crystallization) suggests the possibility of a general principle of organization. This principle could possibly govern not only the organization of biological phenomena but also of those of nonbiological origin.

In this sense, the present work focused on crystallizations occurring in aqueous solutions, based on a simple reason: water is the medium in which all biological processes of organization occur. Water is also the medium that is required for several physicochemical processes of organizational character in nonbiological systems, for example, crystallization, solvation, and micelle formation.

Following this line of reasoning, an investigation concerning the possible effects of *Johrei* on sucrose crystallization in a supersaturated water solution was designed. The selection of sucrose as the crystallization molecule was based on the fact that sucrose is a chemical substance of organic origin. It has great solubility (6.2 molal at 25°C) and crystallizes relatively easily in aqueous solutions, where it interacts strongly with the solvent by forming several hydrogen bonds with water molecules (the solvation process).[27]

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## MATERIAL AND METHODS

The parameter used to evaluate the effects of *Johrei* on crystallization was the ratio between the increment of mass in sucrose crystal seeds and its initial mass. To measure mass increment without extra sucrose molecules from the solution eventually adsorbed to the surface crystal, a specific procedure was developed. The procedure was based on the selective desorption of these molecules, using a balanced mixture of ethanol and isopropanol.

### Selection of Sucrose Crystal Seeds

For this purpose, two criteria were used: a good morphologic condition, observed under stereomicroscope (original magnification × 60), and the mass measurement, using an analytical balance with a precision of ±0.2 mg. An initial set of seeds (>2,000 seeds) was chosen following these criteria, with masses between 1.5 and 2.0 mg. The choice of the range of mass was based on the result of a previous experiment, described later in this paper. For each experiment, 50 crystal seeds were selected randomly from the set of preselected seeds. The sucrose crystal seeds were obtained from sucrose packets purchased at the local market.

### Preparation of Sucrose Supersaturated Solutions

For each experiment, a sucrose solution in water at a concentration of 6.7 ± 0.3 molal was used. To prepare this solution, 23 g of sucrose were added to 10 g of distilled water. The bottle with this mixture, which also contained a magnetic bar for stirring, was sealed to avoid evaporation losses. This bottle was put on a magnetic stirring plate for 30 minutes, followed by immersion in thermostatic bath at approximately 70°C. After total dissolution, the solution was cooled naturally at room temperature (~25°C) until the attainment of thermal equilibrium, and then divided into two samples of equal volume in two bottles, A and B, which were sealed and heated to approximately 70°C for immediate use.

### Experimental Arrangement and Application of *Johrei*

Bottles A and B (tightly sealed) containing the sucrose solution at approximately 70°C were placed on a rectangular table at opposite sides (left and right), so that the bottles were about 130 cm apart from each other. The positions of bottles A and B were randomly determined so that the practitioner could not know which was A or B. The table with the bottles and two chairs (each chair placed in front of each bottle) was positioned in the center of a small room. The thermal control of this environment was performed by an air conditioning system to maintain the room temperature at 25°C ± 1°C. In the control experiment (in absence of the practitioner), bottles A and B in their defined positions were left to settle for 125 minutes, after which the solution was distributed on the well plates.

For the experiments with *Johrei*, the practitioner, alone in the experimental room, chose the bottle which should receive the *Johrei*. Then, the practitioner, sitting in a chair in front of the chosen bottle, registered the position of this bottle (left or right) on paper and inserted it into an envelope for ulterior identification as A or B. Treatment with *Johrei* was performed using one hand at a time alternately, with the palm facing the chosen bottle, keeping a minimum distance of 10 cm between the bottle and the palm for the duration of practice. The practitioner applied 40 minutes of *Johrei*, followed by a pause of 15 minutes. Another application of 40 minutes of *Johrei* practice was conducted, followed by a further pause of 15 minutes, and finally, another 15 minutes of *Johrei* practice.

After performing all measurements and data recording, the envelopes were opened to identify the data that corresponded to the treatment with *Johrei*.

### Measurement Setup

Two kinds of controls were used in the series of experiments described: control experiments or experiments with Johrei. In control experiments, *Johrei* was not applied (without a *Johrei* practitioner present). In this kind of experiment, the data analysis was done considering possible differences between the results, corresponding to odd-numbered and even-numbered columns (Figure 1). In experiments with *Johrei*, there were two sets of seeds, one in crystallization solution that received *Johrei,* and another in solution that did not receive *Johrei*. These experiments were performed as blind experiments, without identification of the treatment to the experimenters until the data were measured and registered. At the time of identification of these blind experiments, the corresponding data sets were named as "with *Johrei*" and "without *Johrei*," the second also being used as a control. For both kinds of experiments, control experiments or experiments with *Johrei*, the measurements were performed as follows.

Every sucrose crystal seed whose initial mass was previously determined was distributed randomly on the bottom of a well in an immunological assay–type well plate (96 wells). Among these wells, only 50 were chosen to receive seeds, arranged as an array of five rows and 10 columns (bounded region, Figure 1). The initial masses of the crystal seeds corresponding to each well were registered.

The solutions of bottles A and B, as explained before, were distributed in these wells, at approximately 25°C (room temper-

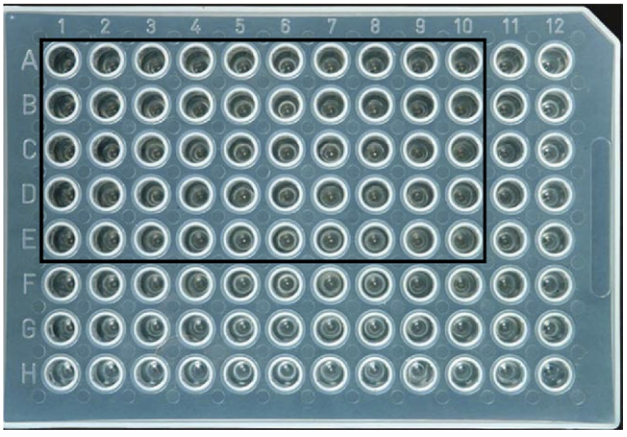


**Figure 1.** Top view of the well plate where the crystal seeds were layered (bounded region). Each well, with one seed, received 200 μl of bottle A solution (odd-numbered columns) or 200 μl of bottle B solution (even-numbered columns).

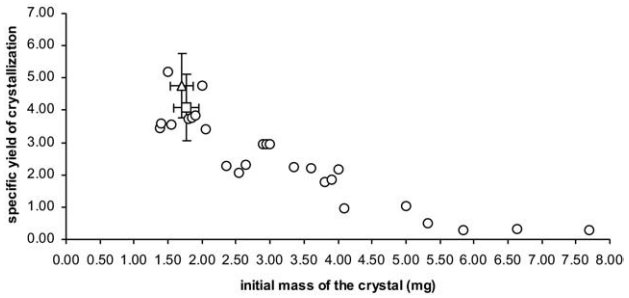


**Figure 2.** Graphic representing the relationship between the specific crystallization yields and the initial mass of crystal seeds. *O,* representation of data generated by the relationship between initial mass and its specific yield of crystallization; Δ, single representation of the relationship between the average values of the initial mass and the specific yield of crystallization, the samples treated with *Johrei*; □, single representation of the relationship between the average values of the initial mass and the specific yield of crystallization, the samples not treated with *Johrei*. *Vertical* and *horizontal bars,* standard deviations associated with the initial mass and the specific yield of crystallization, respectively.

ature). This distribution was carried out so that the wells pertaining to odd-numbered columns one, three, five, seven, and nine received 200 μL of solution from bottle A, and the wells pertaining to even-numbered columns two, four, six, eight, and 10 received an equal volume from bottle B. Then the liquid surface of every well was covered with a layer of mineral oil (60 μL per well) to minimize evaporation of water solution. The plate containing the wells was placed for approximately 72 hours in a temperature-controlled chamber at 26.0°C ± 0.1°C. Thus, the crystallization was carried out at constant conditions of mass, temperature, and pressure. After this step, the oil layer and the sucrose solution were withdrawn with the aid of a micropipette. The crystals grown were collected with a small forceps. The position of every crystal in the array was registered, and the crystals were dried with absorbing paper (Chamex 100, Champion Papel e Celulose LTDA, São Paulo, Brasil, ) to remove any small volume of sucrose solution remaining on the crystal surfaces.

The isolated crystals were transferred to Eppendorf tubes containing 900 μL of a solution of one part isopropanol and three parts anhydrous ethanol. The tubes were submitted to vortex agitation for approximately one minute to minimize the residual sucrose solution adhered to the surface of the crystals. After this washing operation, the crystals were transferred to absorbing paper to evaporate the solution remaining on the surface of every crystal. After this stage of drying, each crystal was weighed using an analytical balance, and the value thus obtained was registered as the final mass, together with the value of its corresponding initial mass.

### Data Analysis of Crystallization

The specific yield of crystallization was calculated for each set in each experiment as being the ratio between the increment of mass in sucrose crystal seeds (difference between the final mass and initial mass) and its initial mass. The control experiments were analyzed using statistical tests to evaluate the homogeneity of the experimental system between odd and even columns for each experiment. The same procedure was performed between each experiment for samples that did not receive treatment with *Johrei* (without *Johrei*). With these analyses, the sensitivity of the experimental system was evaluated, and a baseline was established as being the expected range of specific yield without treatment. A similar analysis was applied to experiments with *Johrei* to identify any effect of this treatment in the behavior of the samples and in relation to control samples (without *Johrei*).

The previously cited envelopes were opened after the end of each experiment. The growth solutions which had been treated with *Johrei* were identified and the correspondence of the data in the blind experiments was done, and the data were labeled as with *Johrei* and without *Johrei*, respectively.

The adherence tests of Lilliefors, Cramér-von Mises and Anderson-Darling were performed to evaluate the normality of data for each experiment. As all the experiments presented data with characteristics of a normal distribution, the homogeneity of these experiments was analyzed by *t* test, assuming different variances. This assumption was made because large differences in variances were observed for some of the experiments.

To organize the experimental data and apply those tests, the programs Excel (Microsoft Corporation, Redmond, Wash), BioEstat 4.0 (Free Download Software - http://www.des.uem.br/downloads.php), and ASSISTAT 7.5 (Free Download Software - http://www.assistat.com/) were used.

## RESULTS

To select the range in the initial mass of the seeds to be used in this work, an initial experiment was performed, where the seeds used presented the broadest possible range of initial mass as available from the seed source. The correlation between initial seed mass and the respective specific crystallization yields was evaluated (Figure 2). The figure illustrates that the seeds with greater initial mass presented a clear trend toward lower values of specific yield of crystallization. The correlation of the data of Figure 2 was analyzed by the Pearson correlation coefficient with an $r$ of −0.89, which indicates a strong correlation (Table 1).

Assuming that a higher specific yield of crystallization could lead to better experimental sensitivity, initial masses with values in the range from 1.5 to 2.0 mg were chosen. For this range of initial mass, Figure 2 represents the overall behavior of crystallization yield of the seeds used in the experiments involving treatment. The data displayed corresponds to the average values of initial mass and specific yield of crystallization for samples

**Table 1.** Pearson Correlation Coefficient (*r*) to the Data from Figure 2[a]

| | |
|---|---|
| Number of pairs | 26 |
| Pearson coefficient, *r* | −0.89 |
| 95% confidence interval | −0.95 to −0.78 |
| Degree of freedom | 24 |
| *P* value | <.0001 |

[a]Initial mass × specific yield of crystallization.

treated and not treated with *Johrei*. The error bars represent the respective standard deviations. It may be seen in Figure 2 that, although a variation of about 25% or less in the specific yield could occur due to the choice of initial mass within the adopted range, the interval of variation corresponding to the ends of error bars was significantly higher (a variation of about 50%).

Considering that the choice of seeds for each experimental group was made randomly, a bias in the result is not expected. If it is the case, a reduction in the variance of each experimental group would be observed; instead an increase in the variation was observed.

The results corresponding to the specific yield of crystallization for all control experiments are presented in Table 2. The results corresponding to the data whose solutions were treated with *Johrei* and the corresponding untreated control solutions are shown in Table 3.

In the Tables 2 and 3 corresponding to experiment 4, a smaller amount of data was shown. For these experiments, malformed crystals were observed, with more than one crystalline body. Such observation was not usual, so the data were disregarded.

A comparison between the average initial and final sizes of crystal seeds can be seen in Figure 3 (original magnification × 60), where the two sample crystals correspond to the initial size of a seed and the size after 72 hours of growth in a supersaturated solution.

**Table 2.** Experimental Data Control, Specific Yields of Crystallization

| Odd Columns (Bottle A Solution) | | | | | Even Columns (Bottle B Solution) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Experiment Number | | | | | Experiment Number | | | | |
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 4.22 | 4.40 | 4.16 | 3.60 | 3.45 | 2.72 | 2.60 | 5.47 | 3.95 | 6.41 |
| 2.79 | 3.76 | 4.80 | 2.47 | 4.42 | 3.60 | 4.10 | 3.20 | 3.33 | 4.41 |
| 1.95 | 4.73 | 5.67 | 3.22 | 5.63 | 4.87 | 4.30 | 5.50 | 3.37 | 5.04 |
| 3.41 | 3.65 | 4.07 | 3.18 | 3.53 | 3.00 | 4.87 | 5.25 | 2.55 | 4.89 |
| 4.60 | 3.61 | 4.75 | 3.17 | 4.77 | 3.38 | 4.27 | 5.25 | 3.82 | 4.06 |
| 3.25 | 3.72 | 4.79 | 5.13 | 5.59 | 3.33 | 3.58 | 4.50 | 4.00 | 5.22 |
| 3.33 | 3.70 | 3.75 | 3.41 | 6.39 | 2.85 | 4.25 | 5.35 | 3.21 | 4.30 |
| 2.37 | 4.21 | 4.00 | 2.10 | 2.62 | 2.95 | 4.93 | 6.76 | 3.00 | 5.41 |
| 3.33 | 4.00 | 4.40 | 2.53 | 4.59 | 3.33 | 4.67 | 6.47 | 3.22 | 4.89 |
| 3.60 | 4.75 | 4.75 | 2.22 | 6.65 | 2.50 | 5.19 | 4.38 | 3.05 | 6.00 |
| 4.32 | 4.22 | 3.80 | 2.00 | 5.00 | 3.69 | 4.27 | 4.05 | 2.89 | 5.42 |
| 3.55 | 4.25 | 4.05 | 4.06 | 5.40 | 4.67 | 4.88 | 5.80 | 2.85 | 4.36 |
| 3.78 | 3.20 | 3.80 | 2.25 | 4.95 | 4.40 | 4.33 | 3.85 | 4.25 | 3.41 |
| 4.73 | 4.44 | 4.63 | 3.56 | 4.55 | 4.20 | 7.00 | 5.18 | 4.00 | 5.10 |
| 2.93 | 3.33 | 5.05 | 1.53 | 5.17 | 3.89 | 4.20 | 3.00 | 3.73 | 3.67 |
| 4.45 | 4.53 | 5.27 | ... | 5.35 | 4.63 | 3.11 | 3.82 | ... | 4.47 |
| 4.00 | 5.81 | 3.75 | ... | 5.00 | 6.13 | 4.00 | 5.40 | ... | 3.45 |
| 3.06 | 4.45 | 4.93 | ... | 3.47 | 3.85 | 3.45 | 4.38 | ... | 3.79 |
| 5.47 | 5.11 | 4.42 | ... | 4.78 | 4.35 | 4.17 | 7.13 | ... | 5.71 |
| 4.45 | 4.87 | 4.50 | ... | 4.76 | 4.26 | 4.47 | 3.73 | ... | 3.30 |
| 3.56 | 3.95 | 3.50 | ... | 3.00 | 4.22 | 3.63 | 4.89 | ... | 6.88 |
| 4.47 | 4.50 | 3.76 | ... | 4.82 | 3.35 | 3.44 | 3.74 | ... | 4.44 |
| 4.10 | 5.80 | 3.47 | ... | 4.10 | 4.40 | 4.00 | 5.06 | ... | 3.05 |
| 3.85 | 3.44 | 4.85 | ... | 3.95 | 4.40 | 3.28 | 3.74 | ... | 4.45 |
| 4.82 | 5.00 | 4.37 | ... | 3.12 | 4.25 | 3.80 | 4.20 | ... | 3.78 |

Ellipses indicate that no data are available.

**Table 3.** Experimental Data of *Johrei*, Specific Yields of Crystallization

| Samples Treated With *Johrei* | | | | | Samples Not Treated With *Johrei* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Experiment Number | | | | | Experiment Number | | | | |
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 3.94 | 3.00 | 5.80 | 5.41 | 5.80 | 3.71 | 3.13 | 5.89 | 2.78 | 6.94 |
| 4.25 | 3.80 | 6.84 | 4.55 | 6.84 | 4.63 | 3.74 | 5.05 | 5.67 | 5.89 |
| 4.39 | 4.78 | 6.70 | 5.15 | 6.70 | 4.31 | 5.27 | 4.90 | 4.12 | 5.05 |
| 3.26 | 4.71 | 6.35 | 4.17 | 6.35 | 3.67 | 4.25 | 5.50 | 5.56 | 4.90 |
| 3.27 | 4.47 | 7.47 | 2.33 | 7.47 | 3.82 | 4.60 | 4.35 | 2.38 | 4.51 |
| 4.50 | 3.71 | 5.89 | 6.27 | 5.89 | 3.50 | 4.44 | 6.35 | 3.00 | 4.35 |
| 4.06 | 3.32 | 6.05 | 4.89 | 6.05 | 4.56 | 3.93 | 5.93 | 4.24 | 6.53 |
| 4.53 | 3.32 | 5.00 | 5.73 | 5.00 | 3.82 | 3.88 | 3.75 | 3.07 | 5.93 |
| 4.13 | 4.88 | 6.93 | 4.56 | 6.93 | 4.87 | 3.56 | 5.25 | 2.73 | 3.75 |
| 4.16 | 3.60 | 3.78 | 5.00 | 3.78 | 3.53 | 3.89 | 5.53 | 4.87 | 5.25 |
| 5.44 | 3.93 | 5.20 | 2.95 | 5.20 | 3.75 | 4.07 | 3.61 | 6.07 | 5.53 |
| 4.50 | 4.65 | 5.82 | 3.58 | 5.82 | 2.89 | 3.88 | 4.87 | 4.35 | 3.61 |
| 4.78 | 4.00 | 5.83 | 4.33 | 5.83 | 3.38 | 4.56 | 4.30 | 6.33 | 4.87 |
| 4.00 | 4.87 | 6.13 | 4.67 | 6.80 | 3.81 | 3.50 | 2.69 | 6.50 | 4.30 |
| 4.78 | 4.26 | 4.87 | 4.59 | 5.67 | 1.94 | 4.94 | 4.00 | 3.33 | 2.69 |
| 4.19 | 4.59 | 5.56 | 3.94 | 5.56 | 4.20 | 3.45 | 3.40 | 3.61 | 4.00 |
| 3.76 | 5.35 | 5.30 | 4.56 | 5.30 | 3.88 | 4.81 | 1.78 | 3.93 | 3.40 |
| 4.07 | 5.00 | 4.18 | 4.07 | 4.18 | 4.39 | 3.42 | 2.53 | 6.80 | 1.78 |
| 4.56 | 4.06 | 4.25 | 5.33 | 4.25 | 2.88 | 3.13 | 5.67 | 3.35 | 2.53 |
| 4.59 | 3.19 | 5.15 | 2.94 | 5.15 | 4.75 | 3.38 | 4.40 | 3.80 | 5.67 |
| 5.47 | 3.21 | 5.11 | 3.47 | 5.11 | 3.61 | 3.95 | 2.71 | 4.56 | 4.40 |
| 4.37 | 5.19 | 4.44 | 4.80 | 4.44 | 3.76 | 2.47 | 3.00 | 2.13 | 2.71 |
| 4.93 | 4.06 | 4.30 | 5.06 | 4.30 | 4.41 | 3.73 | 4.13 | 4.50 | 3.00 |
| 5.60 | 4.31 | 3.11 | 3.35 | 3.11 | 3.87 | 3.82 | 4.80 | 3.06 | 4.13 |
| 4.44 | 4.67 | 4.00 | 4.94 | 4.00 | 4.65 | 6.94 | 2.94 | ... | 4.80 |

Ellipsis indicates that no data are available.

The results from the normality tests performed with the data of Tables 2 and 3 are presented in Tables 4, 5, 6, and 7. These data have a normal distribution within a 95% confidence interval. The normal behavior, together with the relatively large sample size used, made possible the use of the *t* test to evaluate the homogeneity of these data. This test was performed between the data from the odd and even columns in control experiments and between data from treated and untreated columns in the experiments with *Johrei*. However, some of the experiments presented results with large differences in variance, whether in the set of control experiments or in the set of experiments with treatment. Therefore, the F test for homogeneity of variance was also applied to these data. The result of the F test revealed significant differences in the variance of the data corresponding to control experiments three and four and in the data corresponding to experiment four treated with *Johrei*, as presented in Table 8. Thus the *t* test was performed assuming different variances.

Analyzing the results of the *t* test on each control experiment, as presented in Table 9, *t* values for all the experiments except for

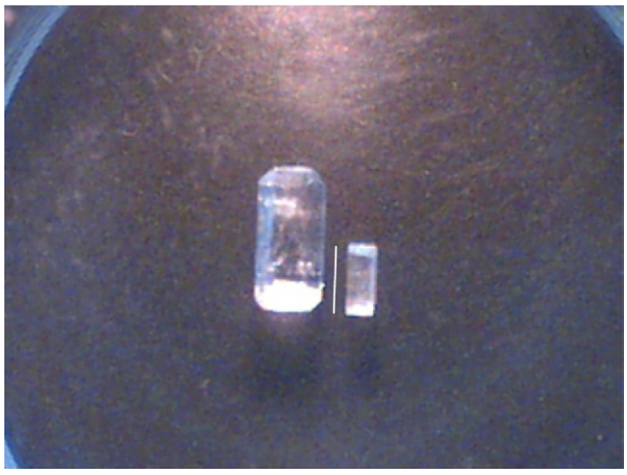

**Figure 3.** Photographic image showing size comparison: a sucrose crystal seed at the beginning of crystallization and another sucrose crystal seed (with similar initial size and mass) after 72 hours of crystal growth. The vertical white bar is equivalent to 1.74 mm.

experiment 3 are below the critical value of *t*, for a confidence interval of 95%. It demonstrates that the data from odd-numbered and even-numbered columns are statistically homogeneous within experimental conditions adopted, representing a single population in the majority of experiments performed.

The same analysis applied to experiments with *Johrei* revealed significant differences between the samples with and without *Johrei* for three of the five experiments performed (one, three, and five in Table 9). These experiments show a different statistical behavior as compared with the control experiments, likely attributable to a *Johrei* effect.

## DISCUSSION

The results of the experiments presented here were quantitatively analyzed by considering specific crystallization yields. This index allowed a computation of the crystal mass growth per unit of seed mass, permitting a comparison between the crystal growth efficacy of solutions treated or not treated with *Johrei*.

The *t* test applied to the control experiments demonstrated a high level of homogeneity among the results pertaining to the growth of seeds in solutions from bottles A and B. Statistically, these two populations are indistinguishable, and thus it is plausible to assume that differences in the results between experiments where one of the bottles received *Johrei* may be attributable to an effect of the treatment.

In the five control experiments, only for one of these experiments (experiment three) the statistical treatment leads to a rejection of the null hypothesis, with a *P* value of 0.04, quite

**Table 4.** Normality Test and Descriptive Statistic. Control Experiments (Odd Columns)

| | Normality | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistical Test | | | | | | | | | | | | | | |
| | Lilliefors | | | | | Cramér–von Mises | | | | | Anderson-Darling | | | | |
| | Experiment Number (Odd Columns) | | | | | Experiment Number (Odd Columns) | | | | | Experiment Number (Odd Columns) | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Cal v[a] | 0.06 | 0.10 | 0.12 | 0.14 | 0.09 | 0.02 | 0.03 | 0.05 | 0.05 | 0.06 | 0.15 | 0.29 | 0.34 | 0.32 | 0.33 |
| Crit v[b] | 0.17 | 0.17 | 0.17 | 0.22 | 0.17 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.70 | 0.70 | 0.70 | 0.68 | 0.70 |
| Norm[c] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| Experiment Number | 1 | 2 | 3 | 4 | 5 |
| Samples, No. | 25 | 25 | 25 | 15 | 25 |
| Minimum value | 1.95 | 3.20 | 3.47 | 1.53 | 2.62 |
| Maximum value | 5.47 | 5.81 | 5.67 | 5.13 | 6.65 |
| Average | 3.77 | 4.30 | 4.37 | 2.96 | 4.60 |
| SD | 0.82 | 0.69 | 0.58 | 0.34 | 1.01 |
| Variance | 0.67 | 0.48 | 0.33 | 0.87 | 1.03 |
| Coefficient of variation | 21.65 | 16.14 | 13.19 | 31.56 | 22.03 |
| Coefficient of ske[d] | −0.21 | 0.55 | 0.28 | 0.67 | −0.09 |
| Coefficient of kur[e] | −0.01 | 0.01 | −0.56 | 0.57 | −0.24 |

[a]Calculated value.
[b]Critical value.
[c]Normality.
[d]Coefficient of skewness.
[e]Coefficient of kurtosis.

**Table 5.** Normality Test and Descriptive Statistic. Control Experiments (Even Columns)

| | Normality | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistical Test | | | | | | | | | | | | | | |
| | Lilliefors | | | | | Cramér–von Mises | | | | | Anderson-Darling | | | | |
| | Experiment Number (Even Columns) | | | | | Experiment Number (Even Columns) | | | | | Experiment Number (Even Columns) | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Cal v[a] | 0.10 | 0.15 | 0.10 | 0.13 | 0.13 | 0.05 | 0.09 | 0.05 | 0.06 | 0.03 | 0.38 | 0.63 | 0.35 | 0.35 | 0.23 |
| Crit v[b] | 0.17 | 0.17 | 0.17 | 0.22 | 0.17 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.70 | 0.70 | 0.70 | 0.68 | 0.70 |
| Norm[c] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| Experiment Number | 1 | 2 | 3 | 4 | 5 |
| Samples, No. | 25 | 25 | 25 | 15 | 25 |
| Minimum value | 2.50 | 2.60 | 3.00 | 2.55 | 3.05 |
| Maximum value | 6.13 | 7.00 | 7.13 | 4.25 | 6.88 |
| Average | 3.89 | 4.19 | 4.80 | 3.41 | 4.63 |
| SD | 0.81 | 0.85 | 1.07 | 0.51 | 0.99 |
| Variance | 0.66 | 0.72 | 1.15 | 0.26 | 0.98 |
| Coefficient of variation | 20.97 | 20.25 | 22.36 | 15.00 | 21.35 |
| Coefficient of ske[d] | 0.51 | 1.25 | 0.39 | 0.08 | 0.45 |
| Coefficient of kur[e] | 0.90 | 4.15 | −0.33 | −1.16 | −0.25 |

[a]Calculated value.
[b]Critical value.
[c]Normality.
[d]Coefficient of skewness.
[e]Coefficient of kurtosis.

close to the confidence limit. The fact that this result is close to acceptance is probably related to the higher variance found in the results for even-numbered columns. The rejection of the null hypothesis for this experiment in particular may be related to accidental changes in the conditions of crystals growth. If so, it may not reveal any effect that could result in false evidence in the experiments involving treatment with *Johrei*. However, when the same test was applied to the comparison between the results with *Johrei* and without *Johrei*, striking differences occurred in the results for the specific crystallization yield for three experiments.

In all experiments, an increase in the growth yield was observed, although in two the results were not statistically significant. Analysis of the control experiments indicate the null hypothesis cannot be rejected when we compare even and odd columns. The null hypothesis can be rejected for the data with *Johrei* treatments after being submitted to the same evaluation. Therefore, this result is marked evidence of the effect of *Johrei* on crystallization. On the other hand, it is not clear how some external conditions may affect the practice of *Johrei*. These can be, for example, the physical or mental health condition of the practitioner, which could modulate to an unknown extent the magnitude of the results attained with the practice.

The primary purpose of this work was to search for scientific evidence that *Johrei* can exert an influence onto nonbiological processes of organization. Those processes are related to a physicochemical phenomenon that occurs in water, that is, as mentioned before, sucrose crystal growth from sucrose crystal seeds in a supersaturated aqueous solution. The following discussion about a possible explanation for the observed results is specifically based on these assumptions.

In general, water is extensively used in a variety of therapies in the realm of alternative medicine, principally those based on energetic principles, such as homeopathy, Bach's flowers therapy,[28] and in the use of bioenergized water. Due to its great importance in this regard, the utilization of water in experimental models is of considerable interest. Water is a ubiquitous medium intervening in the processes of organization and disorganization of the model system.

Water in the liquid state must not be conceived simply as a population of random, mutually independent, and more or less free $H_2O$ molecules. It is a well-established fact that water in the solid state as a liquid, and even as a vapor, has the majority of its molecules in a peculiar configuration in which hydrogen bonds maintain water dipoles grouped and organized in spatial structures, called *water clusters*.[29-33] The architecture of these clusters is by no means static, displaying a persistent dynamic equilibrium that can be modified by factors like heating or solute addition. An effect induced by healing through the hands on this modified equilibrium is evidence favoring the working hypothesis of an organizational change in these structures.

**Table 6.** Normality Test and Descriptive Statistic. Johrei Experiments (With Johrei)

| Normality | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistical Test | | | | | | | | | | | | | | |
| | Lilliefors | | | | | Cramér–von Mises | | | | | Anderson-Darling | | | | |
| | Experiment Number (With *Johrei*) | | | | | Experiment Number (With *Johrei*) | | | | | Experiment Number (With *Johrei*) | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Cal v[a] | 0.13 | 0.10 | 0.08 | 0.11 | 0.09 | 0.06 | 0.05 | 0.03 | 0.06 | 0.03 | 0.45 | 0.33 | 0.16 | 0.33 | 0.23 |
| Crit v[b] | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| Norm[c] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| Experiment Number | 1 | 2 | 3 | 4 | 5 |
| Samples, No. | 25 | 25 | 25 | 25 | 25 |
| Minimum value | 3.26 | 3.00 | 3.11 | 2.33 | 3.11 |
| Maximum value | 5.60 | 5.35 | 7.47 | 6.27 | 7.47 |
| Average | 4.40 | 4.20 | 5.36 | 4.42 | 5.42 |
| SD | 0.58 | 0.68 | 1.09 | 0.93 | 1.11 |
| Variance | 0.34 | 0.46 | 1.18 | 0.87 | 1.23 |
| Coefficient of variation | 13.22 | 16.14 | 20.29 | 21.09 | 20.50 |
| Coefficient of ske[d] | 0.21 | −0.18 | −0.07 | −0.40 | −0.15 |
| Coefficient of kur[e] | 0.46 | −1.05 | −0.49 | 0.00 | −0.58 |

[a]Calculated value.
[b]Critical value.
[c]Normality.
[d]Coefficient of skewness.
[e]Coefficient of kurtosis.

The following is an interpretation of our results using molecular theory and thermodynamics, as is usual in the study of crystallization.[34]

According to the hypothesis that motivates this work, *Johrei* enhances the efficiency of the overall equilibrium restoration mechanisms in both biological and nonbiological systems. From a thermodynamic point of view, the higher crystallization efficiency in the *Johrei*-treated solutions can be attributed to an increase in the amount of energy available to the crystallization process. In other words, there is a higher Gibbs free energy[35] (Gb in the schematic energy diagram of Figure 4) compared with the Gibbs free energy in the untreated solution (represented as Ga in the same figure) after cooling. This is, in some aspects, comparable to the former results obtained with the germination of gamma-irradiated canary seeds.[25] The seeds treated with *Johrei* presented germination values higher than those that were not treated. This means a greater efficiency in the germination process. Similar results were displayed (in terms of specific crystallization yields) by the *Johrei*-treated solutions. This may be credited to higher efficiency of the organization processes. In the case of sucrose crystallization, the difference in the thermodynamic state (Gb > Ga) can be understood as the driving factor that enhances crystallization in the *Johrei*-treated solutions.

Supersaturated solutions have the natural tendency to transfer excess solute molecules (sucrose) to a crystallization center, as a crystal seed, for example. This process is spontaneous when the free energy change is negative and is more favorable as this variation becomes greater. Thus, in the crystallization process, the higher free energy Gb, attributed to the solution with *Johrei*, would promote a higher variation of free energy (negative) when compared with the solution without *Johrei* ($\Delta Gcb > \Delta Gca$; Figure 4), justifying its higher efficiency in this process.

The crystallization process can be compared with a reversible chemical reaction in which the final equilibrium is reached within a finite time interval. In sucrose crystallization, this process can be written in a simplified form as shown below:

sucrose molecules in solution ⇆ sucrose molecules in the seeds (crystallized)

The change of state toward crystallization entails a negative free energy change, as in all spontaneous processes.[35] In sucrose crystallization, besides diffusion, the liberation of sucrose molecules from their solvation water layer (dehydration) is among the most important steps in the crystallization process.[36] This is represented energetically as a potential barrier that hinders the linkage between the sucrose molecules and the growth surface of the crystal seed. To begin the crystallization process, the system must have sufficient available energy to overcome this barrier (free activation energy). The difference between the available energy and the barrier energy will determine the time to reach the reaction equilibrium.

**Table 7.** Normality Test and Descriptive Statistic. Johrei Experiments (Without Johrei)

| | Normality | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistical Test | | | | | | | | | | | | | | |
| | Lilliefors | | | | | Cramér–von Mises | | | | | Anderson-Darling | | | | |
| | Experiment Number (Without *Johrei*) | | | | | Experiment Number (Without *Johrei*) | | | | | Experiment Number (Without *Johrei*) | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Cal v[a] | 0.10 | 0.15 | 0.10 | 0.11 | 0.06 | 0.05 | 0.09 | 0.05 | 0.07 | 0.01 | 0.39 | 0.63 | 0.35 | 0.44 | 0.12 |
| Crit v[b] | 0.17 | 0.17 | 0.17 | 0.18 | 0.17 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| Norm[c] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| Experiment Number | 1 | 2 | 3 | 4 | 5 |
| Samples, No. | 25 | 25 | 25 | 24 | 25 |
| Minimum value | 2.50 | 2.60 | 3.00 | 2.13 | 1.78 |
| Maximum value | 6.13 | 7.00 | 7.13 | 6.80 | 6.94 |
| Average | 3.89 | 4.19 | 4.80 | 4.20 | 4.42 |
| SD | 0.81 | 0.85 | 1.07 | 1.36 | 1.30 |
| Variance | 0.66 | 0.72 | 1.15 | 1.85 | 1.69 |
| Coefficient of variation | 20.97 | 20.25 | 22.36 | 32.44 | 29.42 |
| Coefficient of ske[d] | 0.51 | 1.25 | 0.39 | 0.47 | −0.08 |
| Coefficient of ske[e] | 0.90 | 4.15 | −0.33 | −0.81 | −0.43 |

[a]Calculated value.
[b]Critical value.
[c]Normality.
[d]Coefficient of skewness.
[e]Coefficient of kurtosis.

Based on this line of reasoning, it can be hypothesized that the enhanced crystal growth in the *Johrei*-treated solutions was due to a diminution of the energy barrier, represented by the free activation energy necessary[35] for crystallization. It is probably associated with a higher value of Gibbs free energy in the solutions with *Johrei* than in without *Johrei*.

**Table 8.** F Test for Variances

| | Experiment Number (Control) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | |
| | Odd | Even | Odd | Even | Odd | Even | Odd | Even | Odd | Even |
| Average | 3.77 | 3.89 | 4.30 | 4.19 | 4.37 | 4.80 | 2.96 | 3.41 | 4.60 | 4.64 |
| Variance | 0.67 | 0.66 | 0.48 | 0.72 | 0.33 | 1.15 | 0.87 | 0.26 | 1.03 | 0.98 |
| F cal[a] | 1.00 | | 1.50 | | 3.47 | | 3.33 | | 1.05 | |
| F crit[b] | 1.98 | | 1.98 | | 1.98 | | 2.48 | | 1.98 | |
| Null hypothesis | Accepts | | Accepts | | Rejected | | Rejected | | Accepts | |

| | Experiment Number (*Johrei*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | |
| | With | Without | With | Without | With | Without | With | Without | With | Without |
| Average | 4.40 | 3.86 | 4.20 | 4.03 | 5.36 | 4.34 | 4.42 | 4.20 | 5.42 | 4.42 |
| Variance | 0.34 | 0.44 | 0.46 | 0.76 | 1.18 | 1.50 | 0.87 | 1.85 | 1.24 | 1.69 |
| F cal[a] | 1.31 | | 1.66 | | 1.28 | | 2.13 | | 1.37 | |
| F crit[b] | 1.98 | | 1.98 | | 1.98 | | 1.99 | | 1.98 | |
| Null hypothesis | Accepts | | Accepts | | Accepts | | Rejected | | Accepts | |

[a]F calculated.
[b]F critical.

**Table 9.** *t* Test Assuming Different Variances

| | Experiment Number (Control) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | |
| | Odd | Even | Odd | Even | Odd | Even | Odd | Even | Odd | Even |
| Total of data | 25 | 25 | 25 | 25 | 25 | 25 | 15 | 15 | 25 | 25 |
| Average | 3.78 | 3.89 | 4.30 | 4.19 | 4.37 | 4.80 | 2.96 | 3.41 | 4.60 | 4.64 |
| Variance | 0.67 | 0.66 | 0.48 | 0.72 | 0.33 | 1.15 | 0.87 | 0.26 | 1.03 | 0.98 |
| Degrees of freedom | 48 | | 46 | | 37 | | 22 | | 48 | |
| Value of *t* | 0.49 | | 0.48 | | 1.77 | | 1.64 | | 0.12 | |
| Critical value of *t* (5%) | 1.68 | | 1.68 | | 1.69 | | 1.72 | | 1.68 | |
| P value | .31 | | .48 | | .04 | | .06 | | .45 | |
| Null hypothesis | Accepts | | Accepts | | Rejected | | Accepts | | Accepts | |

| | Experiment Number (*Johrei*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | |
| | With | Without | With | Without | With | Without | With | Without | With | Without |
| Total of data | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 24 | 25 | 25 |
| Average | 4.40 | 3.86 | 4.20 | 4.03 | 5.36 | 4.29 | 4.43 | 4.20 | 5.42 | 4.42 |
| Variance | 0.34 | 0.44 | 0.46 | 0.76 | 1.18 | 1.52 | 0.87 | 1.85 | 1.23 | 1.69 |
| Degrees of freedom | 47 | | 45 | | 47 | | 41 | | 47 | |
| Value of *t* | 3.03 | | 0.76 | | 3.25 | | 0.68 | | 2.92 | |
| Critical value of *t* (5%) | 1.68 | | 1.68 | | 1.68 | | 1.68 | | 1.68 | |
| P value | .002 | | .22 | | .001 | | .25 | | .002 | |
| Null hypothesis | Rejected | | Accepts | | Rejected | | Accepts | | Rejected | |

From a molecular point of view, the proposed energetic changes could be a result of *Johrei* through one or both of the following mechanisms: (1) the arrangement of water molecules in the solvation shell around the sucrose molecules, (2) an effect exerted on the water molecules not directly engaged in solvation, which could promote water molecule arrangements called clusters. The second hypothesis, although possible, must be considered cautiously.

A survey of the current literature about healing through the hands, including *Johrei*, did not yield reports on any equilibrium restoration principle or organization processes. Regarding studies about *Johrei*, the paper of Taft et al[21] can be considered as an example. This work reported a failure to demonstrate any effect of *Johrei* on the rate of glial cancer cell division in vitro. Based on the hypothesis we have offered, perhaps these results would be different if *Johrei* were administered to cancerous glial cells in situ, since the response (biological organization) to this anomaly in this case would be given by the body.

Also seen from a survey of works dealing with *Johrei* (or other types of healing through the hands) is the lack of search for a general principle that explains the observed phenomena in biological and nonbiological systems.

Other possible environmental interferences on the experimental set are infrared effects and infrasound induced by the hands of the practitioner. This makes some sense for Qigong,[37,38] where the practice involves sudden moves of the hands of the practitioner toward the experimental media being treated, as well as an increased temperature of the hands. However, *Johrei* is a practice that is performed with the hand at rest, under a relaxed state of the practitioner, and significant levels of infrasound or other mechanical disturbances in the environment are not expected to be produced by the practice.

In a former unpublished work conducted by the authors, an investigation about the effect of *Johrei* in the surface tension of water was conducted. As surface tension is a physical property that depends on temperature, a parallel investigation was performed to check if the changes in surface tension that were observed could have correlation with a change in the temperature of the water. In that work, thermal effect induced by the hands of a person (who did not intend to perform any healing through the hands) was investigated for water samples of 10-mL volume. This person positioned both hands, like a shell, about five cm from the bottle containing the water sample. A temperature increase up to 0.5°C above the environment temperature was observed. This observation was attributed to thermal radiation being absorbed by the water, coming from the hands of the practitioner. It was found that the temperature increase could sufficiently explain the small changes in surface tension observed there. Compared with those results and that experimental setup, the present experimental setup is much less sensitive to thermal effects due to two reasons. First, in the present work was used a minimum distance that is twice that mentioned above; and, it was used only one hand. Therefore, a thermal effect, if it occurs at all, will likely be of equal or smaller size than the expected random fluctuations in the environment temperature.

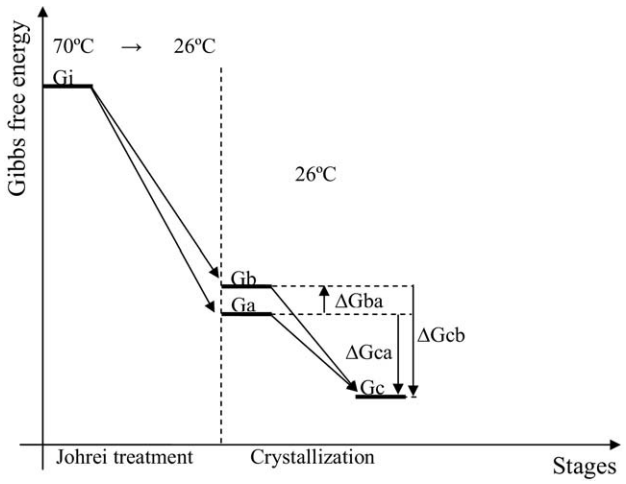


**Figure 4.** Schematic representation of a hypothetical proposal for the free energy evolution during the whole process of sucrose crystallization, showing the differences between the systems treated with *Johrei* and the untreated systems. *Gi*, free energy of sucrose molecules in solution at the beginning of the experiments with Johrei; *Ga,* initial free energy of sucrose molecules in solution untreated with *Johrei*; *Gb,* initial free energy of sucrose molecules in solution treated with *Johrei*; *Gc,* free energy of sucrose molecules on the crystal seed; Δ*Gba,* difference between the initial free energy of sucrose molecules of *Johrei*-treated solutions and sucrose molecules of the untreated solutions; Δ*Gca,* difference in the free energy of sucrose molecules between untreated solution and crystal seed; Δ*Gcb,* difference in the free energy of sucrose molecules between *Johrei*-treated solution and crystal seed.

## CONCLUSIONS

1. This work presents evidence of a positive effect of *Johrei* on sucrose crystal growth from supersaturated solutions previously freed of nucleation by thermal treatment.
2. The results of this work suggest the existence of a general mechanism of restoration and maintenance of equilibrium acting in the biological and in the nonbiological realm (physical and chemical). It also suggests that *Johrei* acts in a synergistic fashion with these mechanisms.
3. In biological and in nonbiological systems, water may act as the target, the vehicle, and the medium for these processes.
4. If, in fact, the therapeutic effect of *Johrei* (and perhaps of other healing through the hands therapies) relies on the restoration and maintenance equilibrium mechanisms, this work provides a base for carrying out future research into this type of therapy.

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