

## Biofield Energy Treatment: Physicochemical and Thermal Characterization of L-Tryptophan

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### Abstract

L-tryptophan is an essential amino acid that needs to be supplemented through protein-rich diet and it helps in growth and nitrogen balance in the humans. The aim of this study is to evaluate the effect of the Trivedi Effect<sup>®</sup>-Consciousness Energy Healing Treatment on the L-tryptophan in terms of its physicochemical and thermal properties by using modern analytical techniques. The method involved dividing the test sample into two parts and providing the Consciousness Energy Healing Treatment to one part (named as Biofield Energy Treated sample), remotely by a renowned Biofield Energy Healer, Dahryn Trivedi; while the other part didn't receive any treatment called a control sample. The particle size values of the treated sample was increased by 4.77% ( $d_{10}$ ), 6.37% ( $d_{50}$ ), 6.72% ( $d_{90}$ ), and 6.49% {D(4,3)}; thus, the specific surface area was increased by 4.35% compared to the control sample. The PXRD peak intensities and crystallite sizes of the treated sample were significantly altered ranging from -82.69% to 30.54% and -17.15% to 179.73%, respectively, in comparison to the control sample. The total weight loss of the treated sample was significantly reduced by 11.60% during the heating process that resulted in a significant increase in the residual amount of the sample by 1093.33% as compared to the control sample. The melting temperature and the latent heat of fusion of the treated sample were significantly increased by 1.12% and 6.79%, respectively, compared to the untreated sample. Hence, the L-tryptophan might form a new polymorph after the Trivedi Effect<sup>®</sup>-Consciousness Energy Healing Treatment that may possess better solubility and bioavailability profile along with improved thermal stability compared with the untreated sample. Thus, the Trivedi Effect<sup>®</sup>-Consciousness Energy Healing Treatment could be considered as a novel approach for designing the formulations with improved drug profile and efficacy. The treated L-tryptophan would be more useful for the treatment of mental health disorders, premenstrual dysphoric disorder (PMDD), attention deficit-hyperactivity disorder (ADHD), obsessive-compulsive disorder, depression, and bipolar disorder, etc.

**Keywords:** Complementary and alternative medicine; L-tryptophan; Consciousness Energy Healing Treatment; The Trivedi Effect<sup>®</sup>; PXRD; TGA/DTG; DSC

### Introduction

Tryptophan was first isolated from casein protein and discovered by Hopkins and Cole in the early 1900s<sup>[1]</sup>, while its molecular structure was determined later by Ellinger and Flamand<sup>[2]</sup>. In amino acids, the L isomer (e.g., L-tryptophan) is used in protein synthesis and has the ability to pass the blood-brain barrier<sup>[3,4]</sup>. L-tryptophan is available in the lowest concentration in the human body among all amino acids<sup>[5]</sup> and has low tissue storage<sup>[6]</sup>. Although it is needed in small amounts in the body for general healthy nutrition; however it is the essential amino acid that needs to be supplied through the diet<sup>[7,8]</sup>. The rich sources of tryptophan include protein-based foods and dietary proteins<sup>[9]</sup> such as dairy, meats, fruits, and seeds, etc. Besides, the meals having high-glycaemic index also increase its availability within the body<sup>[10]</sup>. Tryptophan not only works in the protein formation, but it is also a precursor for various metabolites, such as kynurenine and serotonin. Serotonin is a neurotransmitter that is produced cen-

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trally as well as peripherally by its sole precursor, tryptophan<sup>[11]</sup>. Besides, the kynurenine synthesis is considered the second most important metabolic pathway that is responsible for approximately 90% of tryptophan metabolism<sup>[12]</sup>. Kynurenine acts as the precursor of kynurenic acid, which has the antagonist properties for the glutamate ionotropic receptors. There are other bioactive compounds for which tryptophan acts as the in vivo precursor such as, tryptamine, nicotinamide (vitamin B<sub>6</sub>), melatonin, 3-hydroxykynurenine, and xanthurenic and quinolinic acids<sup>[13]</sup>. Since tryptophan can only be taken through the diet<sup>[14]</sup>; thus, its presence in the blood could be highly influenced by the dietary factors. Also, the other amino acids can affect its uptake in the brain, and thereby the rate of formation of serotonin<sup>[15]</sup>. The reduced levels of L-tryptophan in the body may cause bipolar disorder, depression<sup>[16]</sup>, and obsessive-compulsive disorder, etc.<sup>[17]</sup> Hence, it is given in the form of nutraceutical/pharmaceutical formulations to fulfill the need. Besides, it could also be used in the field of alternative medicine to help people quit smoking<sup>[18]</sup> and in the treatment of mood swings and irritability due to the premenstrual dysphoric disorder syndrome<sup>[19]</sup> as an aid.

The bioavailability of any compound is highly influenced by its physicochemical properties that could be altered to improve its solubility, dissolution, and absorption within the body<sup>[20]</sup>, and thereby to attain the maximum biological activities<sup>[21]</sup>. Consciousness Energy Healing Treatment is one among such novel approaches that showed its significant role in modifying the physicochemical and thermal properties of various compounds<sup>[22,23]</sup>. The use of Energy therapy such as, the Biofield Energy Treatment, against various diseases has been evident now a days as it was found to have advantageous effect and therefore, accepted by the National Center for Complementary and Alternative Medicine (NCCAM) under the field of Complementary and Alternative Medicine (CAM) therapies along with homeopathy, yoga, meditation, acupressure, acupuncture, healing touch, relaxation techniques, hypnotherapy, Pilates, Reiki, Ayurvedic medicine, cranial sacral therapy, traditional Chinese herbs and medicines, etc.<sup>[24,25]</sup> The Trivedi Effect<sup>®</sup>-Consciousness Energy Healing Treatment has already been reported in various literature for its significant effect on the physicochemical properties of the pharmaceuticals/nutraceuticals<sup>[26-28]</sup>, metals, ceramics, and chemicals<sup>[29-31]</sup>, antimicrobial activity<sup>[32-34]</sup>, agricultural productivity<sup>[35,36]</sup>, and in the field of biotechnology<sup>[37,38]</sup>, cancer research<sup>[39]</sup>, and skin and bone health<sup>[40-42]</sup>, etc. In this regard, this research work was designed to analyze the impact of the Biofield Energy Treatment on the physicochemical and thermal characteristics of L-tryptophan with the help of various analytical techniques.

## Materials and Methods

### Chemicals and Reagents

L-tryptophan was purchased from Alfa Aesar, the USA and the other chemicals were of analytical grade purchased in India.

### Consciousness Energy Healing Treatment Strategies

The experimental design includes dividing the L-tryptophan sample into two parts, among which the one part was not provided the Biofield Energy Treatment, and considered as the control sample. Besides, the other part of the sample was exposed to the

Trivedi Effect<sup>®</sup>- Consciousness Energy Healing Treatment for 3 minutes under standard laboratory conditions by the renowned Biofield Energy Healer, Dahryn Trivedi, USA, and known as the Biofield Energy Treated sample. Then, for comparison purpose, the control sample was treated by a “sham” healer, who did not have any knowledge about the Biofield Energy Treatment. The control and the Biofield Energy Treated samples were then stored in sealed conditions and characterized further by using PSA, PXRD, DSC, and TGA/DTG analytical techniques.

### Characterization

The PSA, PXRD, TGA/DTG, and DSC analysis of L-tryptophan were performed. The PSA was performed using Malvern Master sizer 2000, from the UK with a detection range between 0.01  $\mu\text{m}$  to 3000  $\mu\text{m}$  using the wet method<sup>[43,44]</sup>. The PXRD analysis of L-tryptophan powder sample was performed with the help of Rigaku MiniFlex-II Desktop X-ray diffractometer (Japan)<sup>[45,46]</sup>. The average size of crystallites was calculated from PXRD data using the Scherrer's formula (1)

$$G = k\lambda/\beta\cos\theta \quad (1)$$

Where G is the crystallite size in nm, k is the equipment constant (0.94),  $\lambda$  is the radiation wavelength (0.154056 nm for K $\alpha$ 1 emission),  $\beta$  is the full-width at half maximum, and  $\theta$  is the Bragg angle<sup>[47]</sup>.

The TGA/DTG thermograms of L-tryptophan were obtained with the help of TGA Q50 TA instruments. Similarly, the DSC analysis of L-tryptophan was performed with the help of DSC Q200, TA instruments<sup>[48]</sup>.

The % change in particle size, specific surface area (SSA), peak intensity, crystallite size, melting point, latent heat, weight loss and the maximum thermal degradation temperature ( $T_{\text{max}}$ ) of the Biofield Energy Treated sample was calculated compared with the control sample using the following equation 2:

$$\% \text{ change} = \frac{\text{Treated} - \text{Control}}{\text{Control}} \times 100 \quad (2)$$

## Results and Discussion

### Particle Size Analysis (PSA)

The particle size distribution data were presented in Table 1 that helps in analysing the effect of the Biofield Energy Treatment on the treated sample as compared to the control sample. The treated L-tryptophan sample showed a significant reduction in the particle size values at  $d_{10}$  (4.77%),  $d_{50}$  (6.37%),  $d_{90}$  (6.72%), and D(4,3) (6.49%) compared to the control sample (Table 1). The significant decrease in the particle size values of the treated sample resulted in 4.35% increase in the specific surface area (0.096  $\text{m}^2/\text{g}$ ), compared to the control sample (0.092  $\text{m}^2/\text{g}$ ).

**Table 1:** Particle size distribution of the control and Biofield Energy Treated L-tryptophan

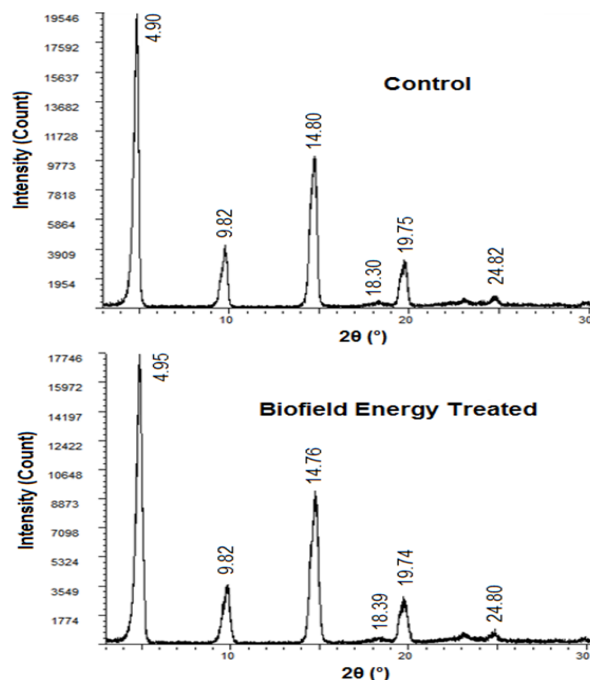
Parameter	d <sub>10</sub> (µm)	d <sub>50</sub> (µm)	d <sub>90</sub> (µm)	D(4,3) (µm)	SSA (m <sup>2</sup> /g)
Control	28.75	146.72	371.33	177.03	0.092
Biofield Energy Treated	27.38	137.37	346.38	165.54	0.096
Percent change (%)	-4.77	-6.37	-6.72	-6.49	4.35

d<sub>10</sub>, d<sub>50</sub>, and d<sub>90</sub>: particle diameter corresponding to 10%, 50%, and 90% of the cumulative distribution, D(4,3): the average mass-volume diameter, and SSA: the specific surface area.

Various techniques have been used now a days to improve the solubility and bioavailability of the drug molecule and one among them is to modify the particle size of the crystalline compound and thereby to increase the surface area<sup>[49]</sup>. The reduced particle size of the drug ultimately increases the surface area available for salvation<sup>[50]</sup>. Thus, the increased surface area of the L-tryptophan sample after the Biofield Energy Treatment might improve the solubility, and thereby the absorption and bioavailability compared with the untreated sample.

**Powder X-ray Diffraction (PXRD) Analysis**

The PXRD analysis of the control and the treated L-tryptophan samples was done and the resulted diffractograms were recorded (Figure 1) and analysed with respect to the differences observed in terms of the relative intensities and crystallite sizes between the samples (Table 2). The diffractograms of both the samples revealed the presence of sharp and intense peaks that indicated the crystalline nature of the control and treated sample; however, some alterations were observed in the Bragg's angles of the peaks of the treated sample in comparison to the control sample. The treated sample also showed significant alterations in the peak intensities and crystallite sizes corresponding to the characteristic peaks in the range from -82.69% to 30.54% and -17.15% to 179.73%, respectively, compared to the control sample. The changes in the Bragg's angles, peak intensities, and crystallite sizes compared to the untreated sample suggested the possible formation of a new polymorph of L-tryptophan due to the Biofield Energy Treatment<sup>[51]</sup>, which might have better solubility and bioavailability profile<sup>[52]</sup> compared with the control sample.



**Figure 1:** PXRD diffractograms of the control and Biofield Energy Treated L-tryptophan.

**Thermal Gravimetric Analysis (TGA)/ Differential Thermogravimetric Analysis (DTG)**

The TGA/DTG techniques help in determining the impact of the Biofield Energy Treatment on the thermal degradation pattern of the L-tryptophan sample. The scientific studies on thermogravimetric analysis of L-tryptophan reported a fast mass loss starting at 526-538 K followed by its thermal degradation and thereby the production of CO<sub>2</sub>, NH<sub>3</sub>, and H<sub>2</sub>O molecules during the whole decomposition process<sup>[53]</sup>. The observed TGA thermograms of the control and the treated L-tryptophan samples (Figure 2) were observed in the similar temperature range. Further, data indicated the reduction in the total weight loss of the treated sample by 11.60% during the thermal degradation process (Table 3). As a result, the residue weight of the treated L-tryptophan sample (12.53%) showed a significant increase by 1093.33% (Table 3) in comparison to the control sample (1.05%). Thus, the TGA result showed the significant increase in the thermal stability of the treated sample after the Biofield Energy Treatment, compared to the control sample.

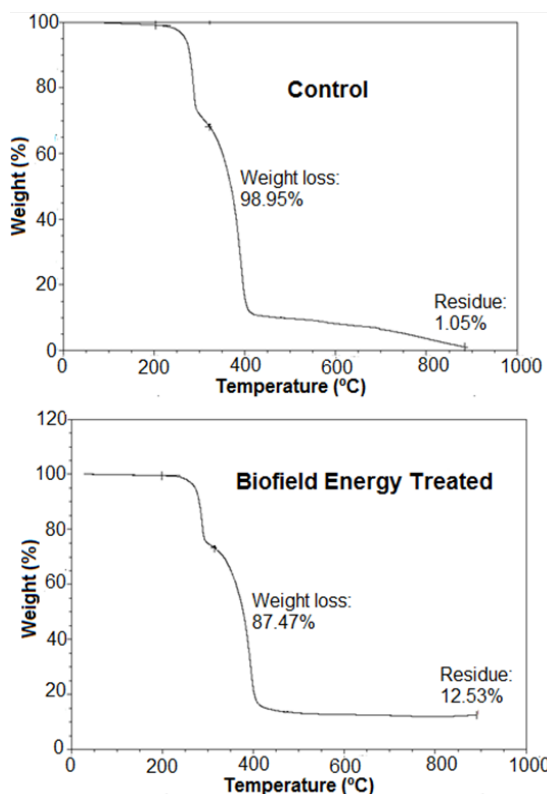
**Table 2:** PXRD data for the control and Biofield Energy Treated L-tryptophan

Entry No.	Bragg angle (°2θ)		Intensity (cps)			Crystallite size (G, nm)		
	Control	Treated	Control	Treated	% change	Control	Treated	% change
1	4.90	4.95	4622	5045	9.15	261.3	216.5	-17.15
2	9.82	9.82	1116	1091	-2.24	208.9	174.7	-16.37
3	14.80	14.76	2341	3056	30.54	208.1	173.1	-16.82
4	18.30	18.39	131	100	-23.66	92.0	104.0	13.04
5	19.75	19.74	859	869	1.16	205.0	173.3	-15.46
6	24.82	24.80	624	108	-82.69	74.0	207.0	179.73

**Table 3:** TGA/DTG data of the control and Biofield Energy Treated samples of L-tryptophan

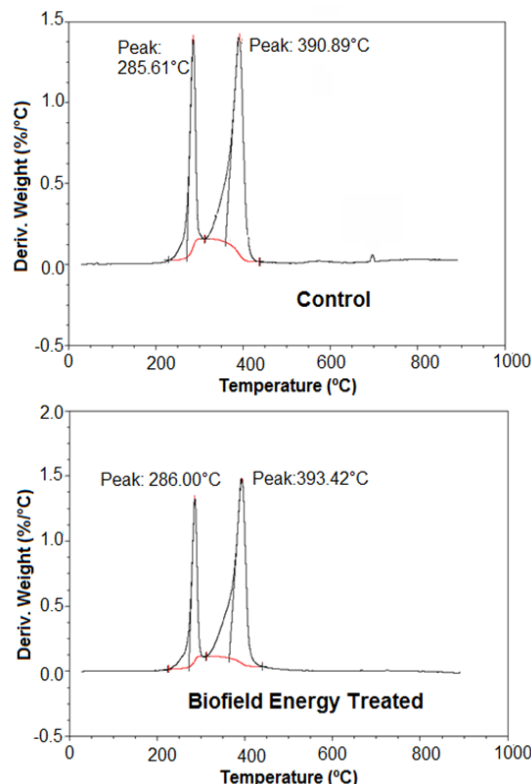
Sample	TGA		DTG	
	Total weight loss (%)	Residue %	Peak 1 $T_{max}$ (°C)	Peak 2 $T_{max}$ (°C)
Control	98.95	1.05	285.61	390.89
Biofield Energy Treated	87.47	12.53	286.00	393.42
% Change	-11.60	1093.33	0.14	0.65

$T_{max}$  = the temperature at which maximum weight loss takes place in TG or peak temperature in DTG



**Figure 2:** TGA thermograms of the control and Biofield Energy Treated L-tryptophan.

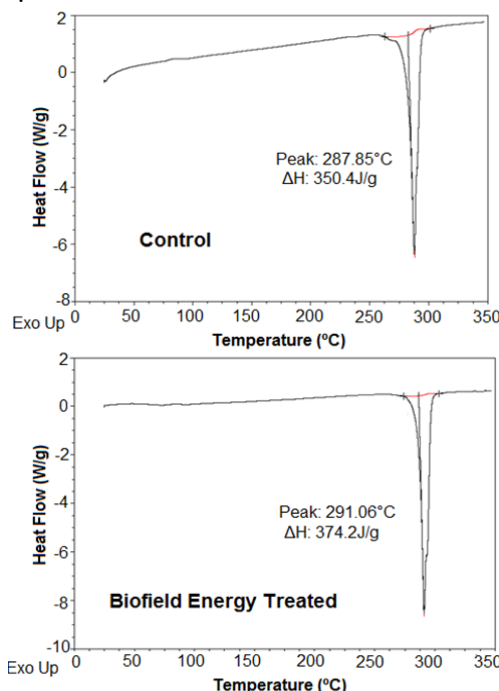
Besides, the DTG thermograms (Figure 3) of both the samples showed two peaks that represent the maximum thermal degradation temperatures ( $T_{max}$ ). The  $T_{max}$  of the treated sample corresponding to 1st and 2nd peaks were observed to be slightly increased by 0.14% and 0.65%, respectively, compared to the control sample. Thus, the DTG data support the TGA results as the increase in  $T_{max}$  temperatures indicated the increase in thermal stability of the treated L-tryptophan sample compared to the untreated sample. Overall, the TGA/DTG results showed that the thermal stability of the treated sample was improved after the Biofield Energy Treatment compared to the untreated sample that might help in providing better storage conditions<sup>[54]</sup>.



**Figure 3:** DTG thermograms of the control and Biofield Energy Treated L-tryptophan.

#### Differential Scanning Calorimetry (DSC) Analysis

The DSC technique helps to analyze the endothermic and exothermic events that may occur during the heating of samples along with the enthalpy change during the process<sup>[55]</sup>. The scientific studies reported the presence of a single endothermic peak in the DSC thermogram of L-tryptophan in the temperature range of 540-577 K during its melting as a result of the heating process<sup>[56]</sup>.



**Figure 4:** DSC thermograms of the control and Biofield Energy Treated L-tryptophan.

The control and the treated sample of L-tryptophan also showed the single endothermic peak in their respective DSC thermograms in the similar temperature range as reported in the literature and the peaks were considered as the melting peak. The data of the DSC thermograms revealed significant alterations in the melting temperature and corresponding  $\Delta H_{\text{fusion}}$  of the treated sample in comparison to the control sample. The melting peak of the control sample was observed at 287.85°C that was shifted to ~4°C in the treated sample and was found at 291.06°C. It indicated the significant increase (1.12%) in the melting temperature of the treated sample after the Biofield Energy Treatment along with 6.79% increase in the  $\Delta H_{\text{fusion}}$  as compared to the control sample (Table 4).

**Table 4:** DSC data for the control and Biofield Energy Treated samples of L-tryptophan

Sample	Peak Temperature (°C)	$\Delta H$ (J/g)
Control Sample	287.85	350.40
Biofield Energy Treated	291.06	374.20
% Change	1.12	6.79

$\Delta H$ : Latent heat of fusion.

Such significant changes in the melting temperature and latent heat of the treated L-tryptophan sample indicated the improved thermal stability as well as some possible alterations crystalline structure of the L-tryptophan due to the Biofield Energy Treatment<sup>[57]</sup> in comparison to the untreated sample.

## Conclusions

The study was done to analyze the effect of the Trivedi Effect®-Consciousness Energy Healing Treatment on the physicochemical and thermal characteristics of L-tryptophan. The particle size values of the Biofield Energy Treated sample was increased by 4.77% ( $d_{10}$ ), 6.37% ( $d_{50}$ ), 6.72% ( $d_{90}$ ), and 6.49% {D(4,3)}; thus, the specific surface area was increased by 4.35% compared to the control sample. The PXRD peak intensities and crystallite sizes of the treated sample were significantly altered ranging from -82.69% to 30.54% and -17.15% to 179.73%, respectively, in comparison to the control sample. The total weight loss of the Biofield Energy Treated sample was significantly reduced by 11.60% during the heating process that resulted in a significant increase in the residual amount of the sample by 1093.33% as compared to the control sample. The melting temperature and  $\Delta H_{\text{fusion}}$  of the Biofield Energy Treated sample was significantly increased by 1.12% and 6.79%, respectively, compared to the untreated sample. Hence, it also indicated the improved thermal stability of the Biofield Energy Treated sample along with some significant changes in the molecular chain pattern compared to the untreated sample. The overall results showed that the Trivedi Effect®-Consciousness Energy Healing Treatment has altered the physicochemical and thermal properties of the L-tryptophan sample significantly that might help in improving the solubility, dissolution, bioavailability, and thermal stability of the L-tryptophan sample as compared to the control sample. Therefore, the approach of L-tryptophan formulation development using the Biofield Energy Treatment could be beneficial regarding the treatment of various diseases such as mental

health disorders, premenstrual dysphoric disorder (PMDD), attention deficit-hyperactivity disorder (ADHD), obsessive-compulsive disorder, depression, and bipolar disorder, etc.

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