September 6, 2018

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Journal of Food Science and Technology: ISSN-2384-5058, Vol. 5(3): pp 095-106, September, 2018.

Full Length Research

The Energy of Consciousness Healing Treatment: Impact on Physicochemical and Thermal Properties of L-Tryptophan

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Accepted 6th September, 2018.

L-tryptophan is an essential amino acid that helps in growth in infants and aids nitrogen balancing in adults, *etc.* This study helps in evaluating the impact of the Trivedi Effect® on the physicochemical and thermal properties of L-tryptophan with the help of various analytical techniques. One part of L-tryptophan sample didn't receive any treatment and was called the control sample, while the other part was given the Biofield Treatment remotely by a renowned Biofield Energy Healer, Gopal Nayak and named as the treated sample. The particle size values were significantly altered by -43.95%(d_{10}), -6.28%(d_{50}), 9.97%(d_{90}), and 10.36%[D(4,3)]; thus, the specific surface area was significantly increased by 51.61% in the treated sample compared to the control sample. The PXRD peak intensities and crystallite sizes were significantly altered ranging from -61.17% to 385.06% and -48.52% to 3.76% respectively, however, the average crystallite size was significantly reduced by 26.03% in the treated sample compared to the control sample. The total weight loss was significantly increased by 17.35%; additionally, the residual amount was significantly reduced by 83.95% in the treated sample compared to the control sample. The ΔH_{fusion} was significantly increased by 10.43% in the treated sample compared to the control sample. Thus, the Biofield Treatment produced the novel polymorph of L-tryptophan that might give better solubility, bioavailability, and thermal stability in nutraceutical/pharmaceutical formulations with and an improved drug profile.

Keywords: L-tryptophan, Consciousness Energy Healing Treatment, The Trivedi Effect®, PXRD, TGA/DTG, DCS

INTRODUCTION

Tryptophan is a type of essential amino acid that performs various vital functions within the body such as, growth in infants and nitrogen balance in adults. It also helps in producing niacin that further plays important role in the generation of the neurotransmitter serotonin. L-tryptophan is naturally abundant in various food ingredients and it provides several health benefits to the human body by itself as well as by increasing the concentration of niacin and serotonin within the body (Sidransky *et al.,* 2002). L-tryptophan is also produced from melatonin after its metabolism, which is important in the process and maintenance of the circadian rhythms of

various biological functions (Ahmad *et al.,* 1966). L-tryptophan is absorbed by the body from food and further metabolized in the form of 5-HTP (5-hyrdoxytryptophan), along with melatonin, serotonin, and niacin (Nehete *et al.,* 2013; Palego et al., 2016). It provides a lot of health benefits due to its presence in the form of serotonin and melatonin which improve sleep quality, promote emotional well-being, relieve depression, anxiety, and aid in managing the stress and pain tolerance. It also causes the narrowing of blood vessels and helps in signal transmission between the nerve cells (Jenkins *et al.,* 2016). However, the presence of fructose malabsorption disorder in the body may cause insufficient absorption of L-tryptophan within the gastrointestinal system and thus can reduce its level in the blood (Ledochowski *et al.,* 2001). The resultant impact of reduced levels of L-tryptophan in the body is depression (Ledochowski *et al.,* 1998), bipolar disorder, and obsessive-compulsive disorder, *etc.* (Maron *et al.,* 2008). Besides, L-tryptophan been also used in the field of alternative medicine in treating the symptoms of mood swings and irritability related to premenstrual dysphoric disorder syndrome (Freeman et al., 2008), and to help people quit the smoking (Bowen *et al.,* 1991) as an aid. It is used in the treatment of facial pain, bruxism (tooth grinding), and in the improvement of athletic performance (Williams *et al.,* 2005), according to some research studies. Moreover, L-tryptophan is also used for treating some mental health disorders, memory loss problem in the elderly, attention deficit-hyperactivity disorder (ADHD) (Bell et al., 2002; Berney *et al.,* 2008), sleep apnoea, seasonal affective disorder (SAD), and anxiety (Argyropoulos *et al.,* 2004), ulcer healing caused by *H. pylori* (Celinski *et al.,* 2011), *etc*.

The physicochemical and analytical properties of any compound are important in deciding the solubility, dissolution, and bioavailability within the body (Mulla et al., 2018). Hence, the maximum effort was done by the researchers to improve such properties of the drug so that maximum biological activities could be attained (Andrysek et al., 2003). Consciousness Energy Healing Treatment is a novel approach that is used by researchers these days to modify such physicochemical and thermal properties of the pharmaceutical compounds (Trivedi et al., 2016a; 2015b). The Biofield Energy Treatment is a form of Energy therapy coming under the category of the Complementary and Alternative Medicine (CAM) that is used against various diseases due to its advantageous effect and is also accepted by the National Center for Complementary and Alternative Medicine (NCCAM) along with other therapies, medicines and practices such as yoga, meditation, healing touch, Reiki, acupuncture, acupressure, Ayurvedic medicine, naturopathy, homeopathy, traditional Chinese herbs and medicines, aromatherapy, Qi Gong, Tai Chi, hypnotherapy, chiropractic/osteopathic manipulation, massage, relaxation techniques, guided imagery, cranial sacral therapy, Rolfing structural integration, mindfulness, and applied prayer (Berman et al., 2004; Barnes et al., 2007). Thus, a Biofield Energy Healer possesses the ability to harness energy from the Universe and can transmit it to any living organism(s) or non-living object(s) around the globe. The impact of the Trivedi Effect®-Consciousness Energy Healing Treatment has been reported in the field of agricultural productivity (Trivedi et al., 2015d, e), biotechnology (Trivedi et al., 2015g; Nayak et al., 2016), physicochemical properties of metals, ceramics, and chemicals (Trivedi et al., 2013; 2016b; 2015k), pharmaceuticals/nutraceuticals (Trivedi et al., 2015a, f, ; 2017b), antimicrobial activity (Trivedi et al., 2015c, j, i), skin health (Singh et al., 2017; Smith et al., 2017), bone health (Koster et al., 2018), and cancer research (Trivedi et al., 2013h), *etc*. This research work was structured with the objective to establish the impact of the Biofield Energy Treatment on the physicochemical and thermal characteristics of L-tryptophan in comparison to the untreated one by using the various analytical techniques such as, powder X-ray diffraction (PXRD), particle size analysis (PSA), thermogravimetric analysis (TGA)/differential thermogravimetric analysis (DTG), and differential scanning calorimetry (DSC).

MATERIALS AND METHODS

Chemicals and Reagents

L-tryptophan was purchased from Alfa Aesar, USA. All other chemicals used during the experiments were of analytical grade available in India.

Consciousness Energy Healing Treatment Strategies

The L-tryptophan sample was divided into two equal parts. One part of the L-tryptophan sample was considered as a control sample where no Biofield Energy Treatment was provided. However, the second part of L-tryptophan was received the Trivedi Effect®-Energy of Consciousness Healing Treatment remotely under standard laboratory conditions for 3 minutes, known as the Biofield Energy Treated L-tryptophan sample. This Biofield Energy Treatment was provided through the healer's unique energy transmission process by the renowned Biofield Energy Healer, Gopal Nayak,

India, to one part of the test sample. Further, the control sample was treated with a "sham" healer for comparison purpose. The "sham" healer did not have any knowledge about the Biofield Energy Treatment. After the treatment, the Biofield Energy Treated and untreated samples were kept in sealed conditions and characterized using PSA, PXRD, TGA/DTG, and DSC techniques.

Characterization

Particle Size Analysis (PSA)

The particle size analysis of the L-tryptophan samples was conducted on Malvern Mastersizer 2000, from the UK with a detection range between 0.01 µm to 3000 µm using wet method (Trivedi *et al.,* 2017c, d). The sample unit (Hydro MV) was filled with a dispersant medium (sunflower oil) and the stirrer operated at 2500 rpm. PSA analysis of L-tryptophan was performed to obtain the average particle size distribution. Where d(0.1) µm, d(0.5) µm, d(0.9) µm represent particle diameter corresponding to 10%, 50%, and 90% of the cumulative distribution. D(4,3) represents the average mass-volume diameter, and SSA is the specific surface area (m^2/g). The calculations were done by using software Mastersizer Ver. 5.54.

The percent change in particle size (d) at below 10% level (d_{10}), 50% level (d_{50}), 90% level (d_{90}), and D(4,3) was calculated using the following equation 1:

$$\% \text{ change in particle size} = \frac{[d_{Treated} - d_{Control}]}{d_{Control}} \times 100. \quad \text{.....(1)}$$

Where $d_{Control}$ and $d_{Treated}$ are the particle size (µm) for at below 10% level (d_{10}), 50% level (d_{50}), and 90% level (d_{90}) of the control and the Biofield Energy Treated L-tryptophan samples, respectively.

The percent change in surface area (S) was calculated using the following equation 2:

$$\% \text{ change in surface area} = \frac{[S_{Treated} - S_{Control}]}{S_{Control}} \times 100 \quad \text{..... (2)}$$

Where $S_{Control}$ and $S_{Treated}$ are the surface area of the control and the Biofield Energy Treated L-tryptophan samples, respectively.

Powder X-ray Diffraction (PXRD) Analysis

The PXRD analysis of control and the Biofield Energy Treated L-tryptophan was performed with the help of Rigaku MiniFlex-II Desktop X-ray diffractometer, Japan (Rigaku, 1997; Zhang *et al.,* 2015). The Cu Kα radiation source tube output voltage used was 30 kV and tube output current were 15 mA. Scans were performed at room temperature. The average size of individual crystallites was calculated from XRD data using the Scherrer's formula 3:

$G = k\lambda/\beta\cos\theta$..... (3)

Where k is the equipment constant (0.94), G is the crystallite size in nm, λ is the radiation wavelength (0.154056 nm for Kα1 emission), β is the full-width at half maximum (FWHM), and θ is the Bragg angle (Langford *et al.,* 2017).

The percent change in crystallite size (G) of L-tryptophan was calculated using the following equation 4:

$$\% \text{ change in crystallite size} = \frac{[G_{Treated} - G_{Control}]}{G_{Control}} \times 100 \quad \text{.....(4)}$$

Where $G_{Control}$ and $G_{Treated}$ are the crystallite size of the control and the Biofield Energy Treated samples, respectively.

Thermal Gravimetric Analysis (TGA)/ Differential thermogravimetric analysis (DTG)

TGA/DTG thermograms of the control and the Biofield Energy Treated L-tryptophan were obtained with the help of TGA Q50TA instruments. Sample of 4-15 mg was loaded to the platinum crucible at a heating rate of 10ºC/min from 25°C to 1000°C with the recent literature (Trivedi *et al.,* 2017b). The % change in weight loss (W) was calculated using the following equation 5:

$$\% \text{ change in weight loss} = \frac{[W_{Treated} - W_{Control}]}{W_{Control}} \times 100 \quad \text{..... (5)}$$

Where $W_{Control}$ and $W_{Treated}$ are the weight loss of the control and the Biofield Energy Treated L-tryptophan, respectively.

The % change in maximum thermal degradation temperature (T_{max}) (M) was calculated using the following equation 6:

$$\% \text{ change in Tmax (M)} = \frac{[M_{Treated} - M_{Control}]}{M_{Control}} \times 100 \quad \text{..... (6)}$$

Where $M_{Control}$ and $M_{Treated}$ are the T_{max} values of the control and the Biofield Energy Treated L-tryptophan, respectively.

Differential Scanning Calorimetry (DSC)

The DSC analysis of L-tryptophan was performed with the help of DSC Q200, TA instruments. Sample of ~1-5 mg was loaded to the aluminium sample

pan at a heating rate of 10ºC/min from 30°C to 350°C (Trivedi *et al.,* 2017b). The % change in melting point (T) was calculated using the following equation 7:

$$\%\ \text{change in melting point} = \frac{[T_{Treated} - T_{Control}]}{T_{Control}} \times 100 \quad \text{..... (7)}$$

Where $T_{Control}$ and $T_{Treated}$ are the melting point of the control and treated samples, respectively.

The percent change in the latent heat of fusion (ΔH) was calculated using the following equation 8:

$$\%\ \text{change in the latent heat of fusion} = \frac{[\Delta H_{Treated} - \Delta H_{Control}]}{\Delta H_{Control}} \times 100 \text{.....(8)}$$

Where $\Delta H_{Control}$ and $\Delta H_{Treated}$ are the latent heat of fusion of the control and treated L-tryptophan, respectively.

RESULTS AND DISCUSSION

Particle Size Analysis (PSA)

The particle size analysis was used to determine the impact of the Biofield Energy Treatment on the particle size distribution of the treated L-tryptophan in comparison to the untreated sample and the data was presented in Table 1. It revealed that the particle size distribution of the Biofield Energy Treated L-tryptophan sample was altered by -43.95%, -6.28%, 9.97%, and 10.36% at d_{10}, d_{50}, d_{90}, and D(4, 3), respectively, compared to the control sample.

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

Parameter	d_{10} (µm)	d_{50} (µm)	d_{90} (µm)	D(4,3)(µm)	SSA(m^2/g)
Control	28.42	143.43	366.29	174.18	0.093
Biofield Treated	15.93	134.42	402.83	192.23	0.141
Percent change* (%)	-43.95	-6.28	9.97	10.36	51.61

d_{10}, d_{50}, and d_{90}: 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. *denotes the percentage change in the Particle size distribution of the Biofield Energy Treated sample with respect to the control sample.

The specific surface area analysis revealed a significant increase in the surface area of the Biofield Energy Treated sample by 51.61% as compared with the SSA of the control sample (Table 1). The researchers have been using several techniques to modify the physicochemical properties of the crystalline compound to increase the surface area and thereby improve the dissolution rate and bioavailability of the drug (Sun *et al.,* 2012). The improved surface area increases the surface area to volume ratio of the drug and therefore the surface area available for salvation (Khadka *et al.,* 2015). Hence, the Biofield Energy Treated L-tryptophan with the improved surface area might be helpful in increasing the solubility, dissolution, and bioavailability of the drug in comparison to the untreated L-tryptophan.

Powder X-ray Diffraction (PXRD) Analysis

The PXRD diffractograms recorded from diffraction analysis of the control and the Biofield Energy Treated L-tryptophan samples are shown in Figure 1 and the corresponding data regarding the peak intensities and crystallite sizes for both the samples are presented in Table 2.

The analysis of the PXRD diffractograms indicated the significant alteration in the Bragg's angles of the characteristic peaks of the treated L-tryptophan sample as compared to the control sample. Such changes might show the changes in the crystalline pattern of the L-tryptophan after the Biofield Energy Treatment. Besides, the peak intensities of the Biofield Energy Treated sample showed significant alterations ranging from -61.17% to 385.06% in comparison to the control sample. On the other hand, the crystallite sizes of the treated sample corresponding to most of the characteristic peaks were altered ranging from 15.19% to 3.76% as compared to the control sample. Moreover, the Biofield Energy Treatment has a significant effect on the average crystallite size of the L-tryptophan sample, as the treated sample showed 26.03% decreased in the average crystallite size (159.51 nm) as compared to the control sample (215.66 nm). Thus, the PXRD data showed that there might be the generation of new

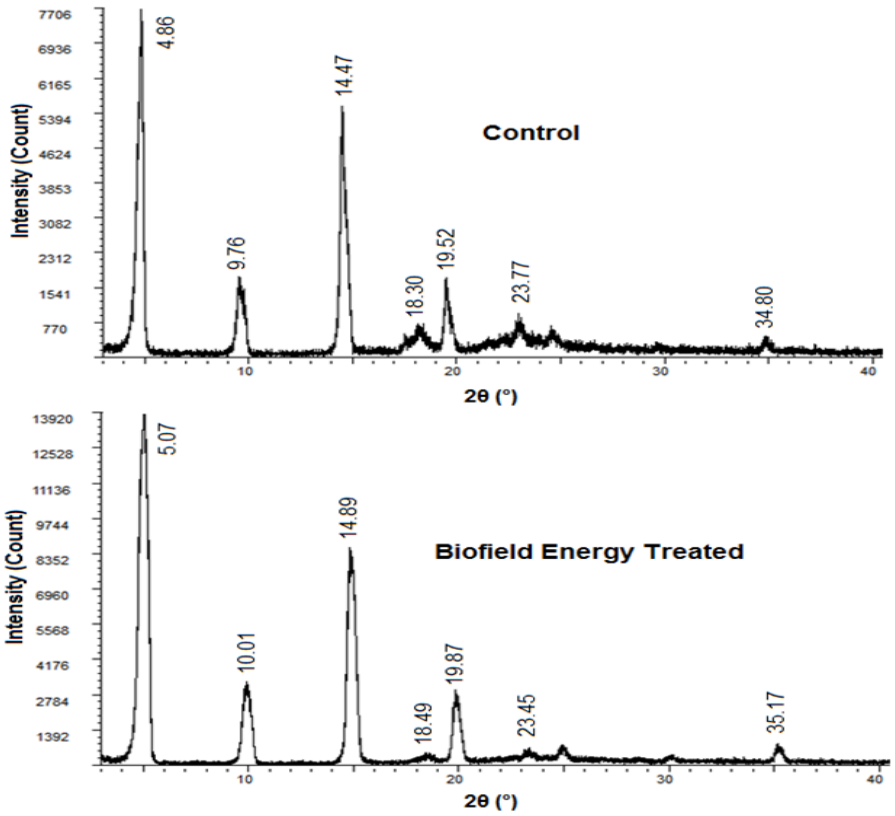

Figure 1: PXRD diffractograms of the control and the Biofield Energy Treated L-tryptophan.

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 [a]	Control	Treated	% change [b]
1	4.86	5.07	1990	4965	149.50	245.8	181.9	-26.00
2	9.76	10.01	381	1032	170.87	186.0	193.0	3.76
3	14.47	14.89	549	2663	385.06	379.0	195.1	-48.52
4	18.30	18.49	291	113	-61.17	119.0	93.0	-21.85
5	19.52	19.87	348	778	123.56	280.0	202.0	-27.86
6	23.77	23.45	869	558	-35.79	29.8	22.6	-24.16
7	34.80	35.17	65	156	140.00	270.0	229.0	-15.19

[a]denotes the percentage change in the intensity of the Biofield Energy Treated sample with respect to the control sample; [b]denotes the percentage change in the crystallite size of the Biofield Energy Treated sample with respect to the control sample.

polymorph after the Biofield Energy Treatment as there were significant changes in the peak intensities and crystallite size of the treated L-tryptophan compared to the untreated sample (Trivedi *et al.,* 2017b). Hence, it is presumed that the Biofield Energy Treated sample might show improved solubility and drug profile (Savjani *et al.,* 2012) as compared to the control L-tryptophan sample.

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

The thermal analysis of the control and the Biofield Energy Treated L-tryptophan samples was done using the TGA/DTG technique. The thermogravimetric analysis of L-tryptophan, as reported in the literature, shows a fast mass loss that starts at 526-538 °K along with the generation of the small molecules of CO_2, NH_3, and H_2O during the thermal degradation (Mello *et al.,* 2015). The TGA thermograms of the control and the treated samples (Figure 2) were observed to be similar as reported in the literature. The analysis of the TGA thermograms showed 17.35% increase in the total weight loss of the treated L-tryptophan after the Consciousness energy healing

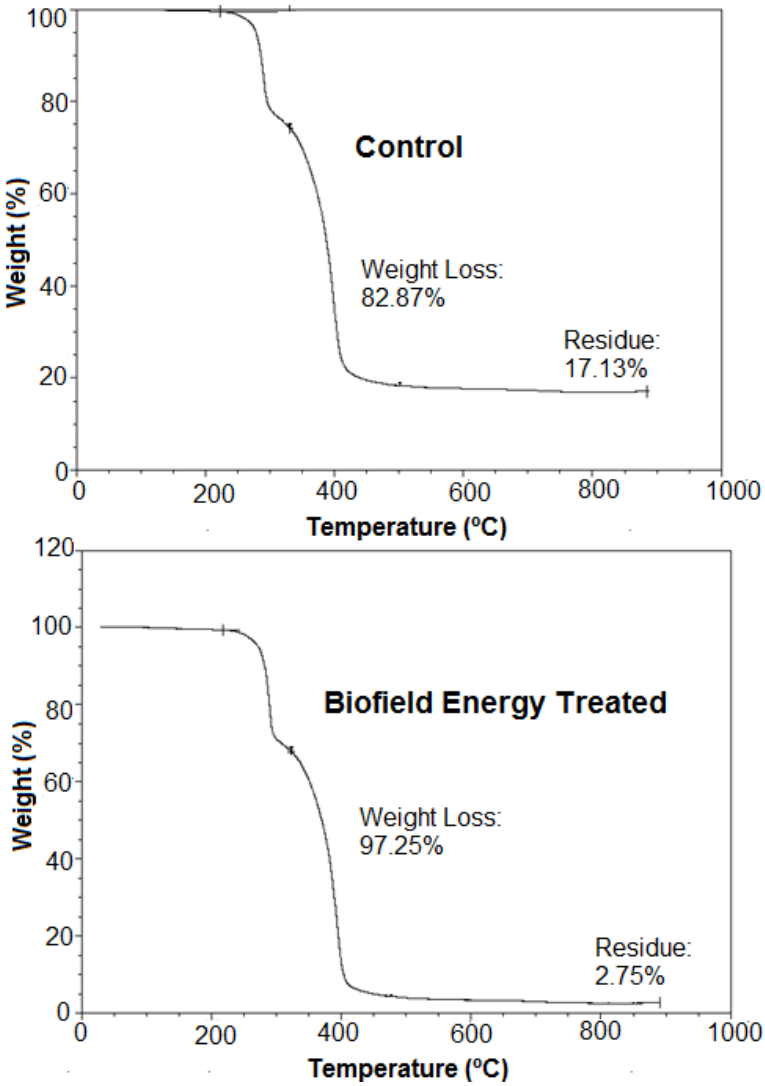

Figure 2: TGA thermograms of the control and the Biofield Energy Treated L-tryptophan.

Table 3: TGA/DTG data of the control and the 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	82.87	17.13	289.71	399.02
Biofield Energy Treated	97.25	2.75	288.75	393.32
% Change*	17.35	-83.95	-0.33	-1.43

*denotes the percentage change of the Biofield Energy Treated sample with respect to the control sample, T_{max} = the temperature at which maximum weight loss takes place in TG or peak temperature in DTG.

treatment; as the weight loss for treated sample was observed to be 97.25% in comparison to the control sample (82.87% wt. loss) after the thermal degradation process (Table 3). The residue amount of the Biofield Energy Treated sample was significantly reduced by 83.95% (Table 3) as compared to the control L-tryptophan sample. It indicated that the thermal stability of the treated L-tryptophan sample might reduce as compared to the control sample.

The DTG thermograms of both, the control and the Biofield Energy Treated samples (Figure 3) showed two peaks. This analysis indicated that the treated L-tryptophan sample showed a slight decrease in the maximum degradation temperature (T_{max}) corresponding

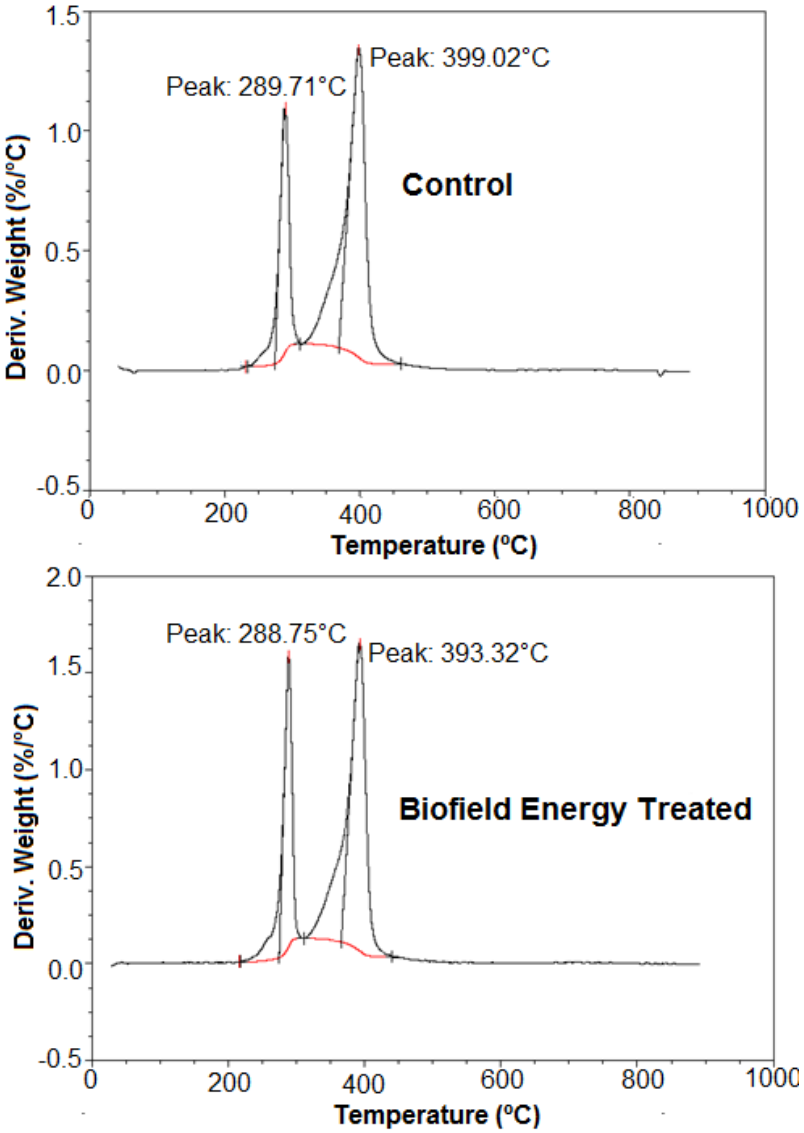

Figure 3: DTG thermograms of the control and the Biofield Energy Treated L-tryptophan.

to 1st and 2nd peak by 0.33% and 1.43%, respectively, as compared to the control sample. It also supports the TGA data as there was a reduction in the temperatures at which maximum thermal degradation had taken place in the treated sample. Overall, the TGA/DTG studies indicated the increase in the thermal degradation of the Biofield Energy Treated sample as compared with the control L-tryptophan sample.

Differential Scanning Calorimetry (DSC) Analysis

The DSC technique is used here to analyze the enthalpy of the control and the Biofield Energy Treated L-tryptophan samples during their melting, along with any other endothermic and exothermic events that might take place during their heating (Jodar *et al.,* 2015). The literature corresponding to the melting behaviour of L-tryptophan reported the single endothermic peak in the temperature range of 540-577 °K in the DSC thermogram (Daniela *et al.,* 2017).

The DSC thermograms obtained from the analysis of both the samples were found similar to the literature as there was a single endothermic peak in both the thermograms (Figure 4), *i.e.,* the melting peak. The further analysis showed that the melting temperature for the control and the Biofield Energy Treated sample was similar (Table 4). However, the ΔH_{fusion} of the treated L-

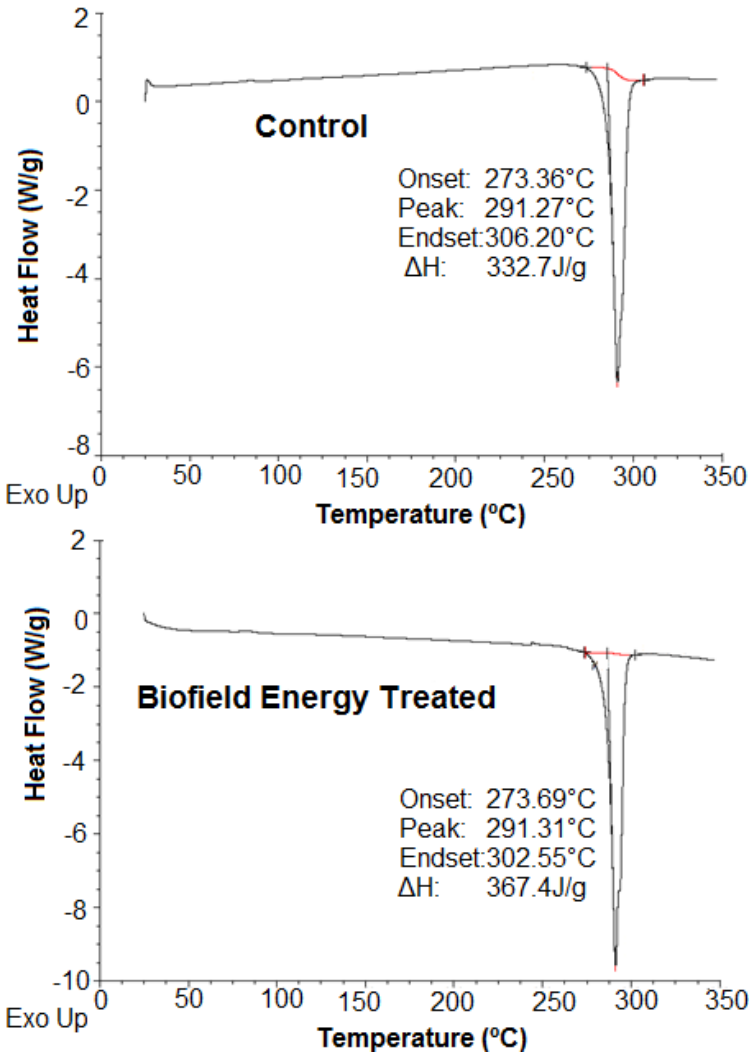

Figure 4: DSC thermograms of the control and the Biofield Energy Treated L-tryptophan.

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

Sample	Peak Temperature (°C)	ΔH (J/g)
Control Sample	291.27	332.70
Biofield Energy Treated	291.31	367.40
% Change*	0.01	10.43

ΔH: Latent heat of fusion, *denotes the percentage change of the Biofield Energy Treated sample with respect to the control sample.

tryptophan sample (367.40 J/g) was significantly increased by 10.43% compared to the control sample (332.70 J/g).

Such increase in the ΔH of the Biofield Energy Treated sample suggested there were some changes happened at the molecular level after the Biofield Energy Treatment (Zhao *et al.,* 2015) as compared to the untreated sample.

CONCLUSION

The study results showed that there has been a significant impact on the crystallite size, particle size, particle area, and thermal properties of the Trivedi Effect®-Consciousness Energy Healing treated L-tryptophan in comparison to the untreated sample. The particle size analysis indicated the altered particle size values of the Biofield Energy Treated L-tryptophan sample at d_{10}, d_{50}, d_{90}, and D(4,3) after the Biofield Energy Treatment were -43.95%, -6.28%, 9.97%, and 10.36%, respectively compared to the control sample. Additionally, the surface area of the Biofield Energy Treated sample was observed to be significantly increased by 51.61% as compared to the untreated L-tryptophan sample. It indicated there might be the improvement in the solubility and absorption profile of the Biofield Energy Treated sample in comparison to the untreated sample. The PXRD data showed significant alterations in the Bragg's angles of the highest intensity peak along with the other characteristic peaks of the Biofield Energy Treated sample, when compared with the control sample. Apart from that, the Biofield Energy Treated sample revealed significant changes in the peak intensities and crystallite sizes of the peaks present in the diffractogram ranging from -61.17% to 385.06% and -48.52% to 3.76%, respectively compared to the control sample. The Biofield Energy Treatment on the L-tryptophan sample resulted in the significant reduction in the average crystallite size by 26.03% as compared to the control sample. Thus, the PXRD data revealed some major changes in the crystalline structure and properties of the L-tryptophan sample after the Biofield Energy Treatment and suggests the possibility of generation of a new polymorph of L-tryptophan. The thermal analysis using TGA/DTG studies suggests significant increase (17.35%) in the total weight loss of the treated sample during the thermal degradation, which resulted in 83.95% reduction in the residual amount as compared to the control L-tryptophan sample. Moreover, the DTG thermogram of both, the control and the treated sample showed two peaks. The T_{max} corresponding to 1st and 2nd peak of the treated sample were observed to be slightly reduced by 0.33% and 1.43%, respectively, compared to the untreated sample. Thus, the thermal analysis revealed increased thermal degradation of the Biofield Energy Treated sample in comparison to the untreated sample. The ΔH_{fusion} of the Biofield Energy Treated L-tryptophan sample was observed to be significantly increased by 10.43% in comparison to the control sample. The Trivedi Effect®-Consciousness Energy Healing Treatment of the L-tryptophan sample might result in the generation of new polymorph with improved solubility, absorption, and bioavailability profile along with altered thermal stability as compared with the untreated sample. Therefore, the Biofield Energy Treated L-tryptophan might be useful for the development of better bioavailable formulation, which can be used for the prevention and treatment of various diseases such as mental health disorders, bruxism, facial pain, seasonal affective disorder, premenstrual dysphoric disorder, sleep apnoea, attention deficit-hyperactivity disorder (ADHD), anxiety, obsessive-compulsive disorder, depression, bipolar disorder, and sleep apnea, *etc*.

ACKNOWLEDGEMENTS

The authors are grateful to Central Leather Research Institute, SIPRA Lab. Ltd., Trivedi Science, Trivedi Global, Inc., Trivedi Testimonials, and Trivedi Master Wellness for their assistance and support during this work.

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