Journal of Pharmacy and Pharmaceutics

OMMEGA Publishers
Answering Intelligence

ISSN: 2377-1313
OPEN ACCESS

Research article

DOI: 10.15436/2377-1313.18.2041

Evaluation of the Physicochemical and Thermal Properties of Sulfamethoxazole: Influence of the Energy of Consciousness Healing Treatment

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Abstract

Sulfamethoxazole is a broad spectrum antibiotic that acts as a bacteriostatic antibacterial agent. This study was aimed to analyze the effect of Consciousness Energy Healing Treatment (the Trivedi Effect®) on the physicochemical and thermal properties of sulfamethoxazole with the help of advanced analytical techniques. Sulfamethoxazole sample was divided into two parts. Among these, one part received Consciousness Energy Healing Treatment remotely by a well-known Biofield Energy Healer, Alice Branton and termed as the treated sample. While the other part did not receive the Consciousness Energy Healing Treatment called a control sample. The study revealed that the particle size values in the treated sample were significantly reduced by 19.71% (d_{10}), 6.28 % (d_{50}), 5.40 % (d_{90}), and 7.98 % {D (4, 3)}; thus, the specific surface area was significantly increased by 12.63% compared with the untreated sample. The powder XRD peak intensities and crystallite sizes were altered significantly ranging from -32.49% to 120.17% and 0.45% to 101.86%, respectively; whereas, the average crystallite size was significantly increased by 33.13% in the treated sample compared with the control sample. The TGA data reported 8.35% increase in total weight loss and 19.55% significant reduction of the residual amount in the treated sample compared with the control sample. The latent heat of fusion was significantly increased by 10.34% and the degradation temperature along with the corresponding latent heat of decomposition of the treated sample was increased by 5.52% and 11.16%, respectively compared with the untreated sample. The Trivedi Effect®-Consciousness Energy Healing Treatment might have created a new polymorphic form of sulfamethoxazole which would be better soluble and bioavailable compared with the untreated sample. The Trivedi Effect Treated sulfamethoxazole might be more beneficial for designing more efficacious novel nutraceutical / pharmaceutical formulations for the prevention and treatment of various diseases such as urinary tract infections, ear infections, traveler's diarrhea, shigellosis, bronchitis, and *Pneumocystis jiroveci* pneumonia, etc.

Keywords: Complementary and Alternative Medicine; Sulfamethoxazole; Consciousness Energy Healing Treatment; The Trivedi Effect®; PXRD; Particle size; TGA / DTG; DSC

Introduction

Sulfamethoxazole is a broad spectrum antibiotic used to treat different types of infection caused by bacteria. It works as a bacteriostatic antibacterial agent, which interferes with the folic acid synthesis in most of the susceptible bacteria[1]. Chemically it is characterized as sulfonamides with a major mechanism of action as a Cytochrome P450 2C9 inhibitor. However, it inhibits the bacterial synthesis of dihydrofolic acid by competing with Para Amino Benzoic Acid (PABA) for binding to dihydropteroate synthetase. By this mechanism, sulfamethoxazole inhibits bacterial nucleotides and DNA synthesis[2]. Various studies have shown that sulfamethoxazole was used in combination with the trimethoprim to treat urinary tract infections, traveler's diar-

Received date: December 9, 2018
Accepted date: December 20, 2018
Publish date: December 26, 2018

Citation: Branton, A., et al. Evaluation of the Physicochemical and Thermal Properties of Sulfamethoxazole: Influence of the Energy of Consciousness Healing Treatment (2018) J pharma pharmaceutics 5(2): 92- 98.

rhoea, ear infections, bronchitis, shigellosis, and *Pneumocystis jiroveci* pneumonia[3]. Some antimicrobial studies have shown that antimicrobial bacterial resistance develops very slowly with both sulfamethoxazole and trimethoprim in combination compared with either sulfamethoxazole or trimethoprim alone. Sulphonamides were generally used alone for the tuberculosis treatment since 1940s[4]. However, some common associated adverse effects are related to their treatment such as nausea, vomiting, loss of appetite, and skin rashes. Sulfamethoxazole is rapidly absorbed orally while it is also well-absorbed topically. The free forms of sulfamethoxazole are considered to be the therapeutically active forms. Approximately 70% of sulfamethoxazole are bound to plasma proteins. Bioavailability and stability profile of any drug depends upon its stability, analytical profile[5]. Further, physicochemical properties are very important in the different role of pharmaceutical compounds such as in its dissolution, absorption, and bioavailability profile. Therefore, in order to improve the physiochemical profile such as such as particle size, crystalline structure, crystallite size, surface area, *etc*., which have direct influence to achieve maximum biological activities; research has been carried to alter such properties[6,7].

Consciousness Energy Healing Treatment was reported in many scientific studies that showed the modification of the physical, structural, and thermal properties of many pharmaceutical compounds[8-10]. Biofield Energy Healing Therapy has been considered as a Complementary and Alternative Medicine (CAM), and was accepted by the National Institutes of Health (NIH) and National Center for Complementary and Alternative Medicine (NCCAM) along with homeopathy, Ayurveda medicine, traditional Chinese herbs and medicines, massage, acupuncture, yoga, meditation, Reiki, hypnotherapy, Tai Chi, Qi Gong, aromatherapy, chiropractic/osteopathic manipulation, cranial sacral therapy, *etc*.[11] against many diseases. Thus, a human has the ability to harness energy from the universal and can transmit it to any living organism(s) or non-living object(s) around the globe. The Trivedi Effect®-Consciousness Energy Healing has been widely reported worldwide in pharmaceuticals, nutraceuticals, and in pure compounds. Biofield Energy Treatment (the Trivedi Effect®) has shown a significant alteration in physiochemical properties and overall behaviour of an atom/ion possibly through neutrinos[12]. The Trivedi Effect®-Consciousness Energy Healing Treatment has been reported with significant revolution in the physicochemical properties of metals, chemicals, ceramics and polymers[13-15], agricultural productivity[16,17], antimicrobial activity[18-20], biotechnology[21,22], skin health[23,24], nutraceuticals[25,26], cancer research[27,28], and bone health[29,30]. Therefore, this study was designed to determine the impact of the Trivedi Effect®-Consciousness Energy Healing Treatment on the physicochemical, and thermal properties of sulfamethoxazole using powder XRD, Particle Size Analysis (PSA), Thermo Gravimetric Analysis (TGA) / Differential Thermo gravimetric Analysis (DTG), and Differential Scanning Calorimetry (DSC).

Materials and Methods

Chemicals and Reagents: The sulfamethoxazole was purchased from Sigma Aldrich (USA) and other chemicals were of analytical grade purchased in India.

Consciousness Energy Healing Treatment Strategies: The sulfamethoxazole test sample was divided into two equal parts. One part of sulfamethoxazole sample was considered as a control sample where no Biofield Energy Treatment was provided. Further, the control sample was treated with a "sham" healer (the sham healer did not know anything about the Biofield Energy Treatment). However, the other part of sulfamethoxazole was treated with the Trivedi Effect®-Consciousness Energy Healing Treatment remotely under standard laboratory conditions for 3 minutes by the famous Biofield Energy Healer, Alice Branton (USA), and known as a Biofield Energy Treated sulfamethoxazole. After the treatment, the Biofield Energy Treated and untreated samples were characterized using PXRD, PSA, TGA / DTG, and DSC techniques.

Characterization: The PSA, PXRD, DSC, and TGA analysis of sulfamethoxazole was performed. The PSA was performed using Malvern Mastersizer 2000, from the UK with a detection range between 0.01 µm to 3000 µm using the wet method[31,32]. The PXRD analysis of sulfamethoxazole powder sample was performed with the help of RigakuMiniFlex-II Desktop X-ray diffractometer (Japan)[33,34]. 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), λ is the radiation wavelength (0.154056 nm for Kα1 emission), β is the full-width at half maximum, and θ is the Bragg angle[35].

Similarly, the DSC analysis of sulfamethoxazole was performed with the help of DSC Q200, TA Instruments. The TGA / DTG thermo grams of sulfamethoxazole were obtained with the help of TGA Q50 TA instruments[36].

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 (Tmax) of the Biofield Energy Treated sulfamethoxazole was calculated compared with the control sample using the following equation 2:

$$\% \text{ Change} = [\text{Treated} - \text{Control}]/\text{Control} \times 100 \quad (2)$$

Results and Discussion

Particle Size Analysis (PSA): The particle size analysis of the control and Biofield Energy Treated sulfamethoxazole samples were done and the results are presented in Table 1. The particle size distribution of the control sulfamethoxazole sample was found at d_{10} = 17.55 µm, d_{50} = 47.46 µm, d_{90} = 104.38 µm, and D (4, 3) = 55.65 µm. Moreover, the particle size distribution of the Biofield Energy Treated sample was observed at d_{10} = 14.09 µm, d_{50} = 44.48 µm, d_{90} = 98.74 µm, and D (4, 3) = 51.21 µm. The analysis showed that the particle size values at d_{10}, d_{50}, d_{90}, and D (4, 3) in the Biofield Energy Treated sample were significantly decreased by 19.71%, 6.28%, 5.40%, and 7.98%, respectively, compared to the control sample.

Table 1: Particle size distribution of the control and Biofield Energy Treated sulfamethoxazole.

Parameter	d_{10}(µm)	d_{50}(µm)	d_{90}(µm)	D(4,3)(µm)	SSA(m^2/g)
Control	17.55	47.46	104.38	55.65	0.285
Biofield Treated	14.09	44.48	98.74	51.21	0.321
Percent change (%)	-19.71	-6.28	-5.40	-7.98	12.63

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.

On the other hand, the specific surface area of the Biofield Energy Treated sulfamethoxazole (0.321 m^2/g) was found to be increased by 12.63% compared with the control sample (0.285 m^2/g), which might occur as a result of the reduction of particle size of the treated sample. Thus, it is presumed that the Trivedi Effect® might act as an external force that possibly caused the reduced particle sizes of the sulfamethoxazole sample. It was reported that the increased surface area of the drug might be useful in improving the bioavailability profile by enhancing its solubility, dissolution rate, and absorption parameters[37,38]. Hence, it could be anticipated that the Biofield Energy Treated sulfamethoxazole might show better bioavailability compared to the untreated sample.

Powder X-ray Diffraction (PXRD) Analysis: The PXRD diffractograms of the control and Biofield Energy Treated sulfamethoxazole samples are shown in Figure 1. The diffractograms of both the samples showed sharp and intense peaks thereby indicated the crystalline nature of both the samples.

The data revealed alterations in the Bragg's angle of the characteristic peaks of the Biofield Energy Treated sample compared with the control sample. The highest peak intensity (100%) was observed at 2θ equal to 20.7° (Table 2, entry 6) in the PXRD diffractogram of the control sample, while at 2θ equal to 20.6° in the Biofield Energy Treated samples. Moreover, the peak intensities of the Biofield Energy Treated sample showed significant alterations in the range from -32.49% to 120.17% compared to the control sample. Such alterations in the peak intensities indicated some changes in the crystallinity of the Biofield Energy Treated sample compared with the untreated one. On the other hand, the crystallite sizes of the Biofield Energy Treated sample regarding the characteristic diffraction peaks were also observed to be significantly increased in the range from 0.45% to 101.86% sample compared to the control sample. Besides, the average crystallite size of the Biofield Energy Treated sample (340.62 nm) was also found to be significantly increased by 33.13% compared with the control sample (255.85 nm). Thus, the overall results indicated towards the alterations in the crystallinity as well as the crystallite size of the Biofield Energy Treated sulfamethoxazole sample compared to the untreated sample.

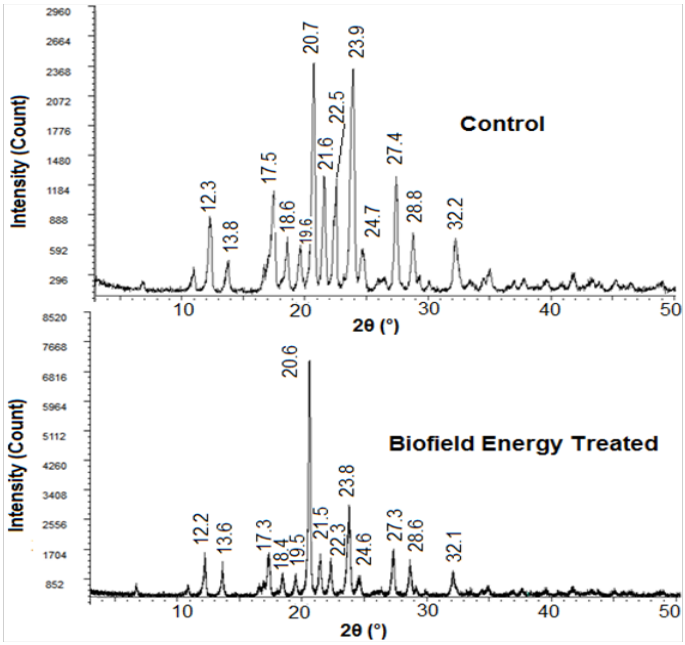

Figure 1: PXRD diffractograms of the control and Biofield Energy Treated sulfamethoxazole.

Table 2: PXRD data for the control and Biofield Energy Treated sulfamethoxazole.

Entry No.	Bragg angle (°2θ)		Intensity (cps)			Crystallite size (G, nm)		
	Control	Treated	Control	Treated	% change	Control	Treated	% change
1	12.3	12.2	243	210	-13.58	276	321	16.30
2	13.8	13.6	98	146	48.98	257	402	56.42
3	17.5	17.3	394	266	-32.49	161	325	101.86
4	18.6	18.4	126	144	14.29	241	365	51.45
5	19.6	19.5	110	87	-20.91	317	369	16.40
6	20.7	20.6	590	1299	120.17	278	471	69.42
7	21.6	21.4	272	240	-11.76	294	368	25.17
8	22.5	22.3	266	180	-32.33	293	342	16.72
9	23.9	23.8	739	660	-10.69	230	280	21.74
10	24.7	24.6	128	146	14.06	224	225	0.45
11	27.4	27.3	312	286	-8.33	287	336	17.07
12	28.8	28.6	189	193	2.12	276	312	13.04
13	32.2	32.1	192	200	4.17	192	312	62.50

According to literature, the Biofield Energy Treatment might affect the crystalline structure and crystal morphology of compounds and thereby may produce a new polymorph by altering the peak intensities and crystallite sizes of the compound[39,40]. Hence, it could be presumed that the significant changes occurring in the peak intensities and crystallite size of the Biofield Energy Treated sample might result due to the formation of a new polymorph of the sulfamethoxazole sample, which may ensure its better drug profile than the untreated sample.

Thermal Gravimetric Analysis (TGA) / Differential Thermogravimetric Analysis (DTG): The TGA / DTG technique was used to determine the thermal stability profile of the control and Biofield Energy Treated sulfamethoxazole samples. The TGA

thermograms of both the samples (Figure 2) showed significant thermal degradation and the data revealed that the Biofield Energy Treated sulfamethoxazole showed 8.35% increase in weight loss during the sample degradation. As a result, the residue amount of the treated sample was observed to be reduced by 19.55% (Table 3) compared with the control sample. It showed that the thermal stability of the Biofield Energy Treated sulfamethoxazole sample was significantly reduced compared to the control sample.

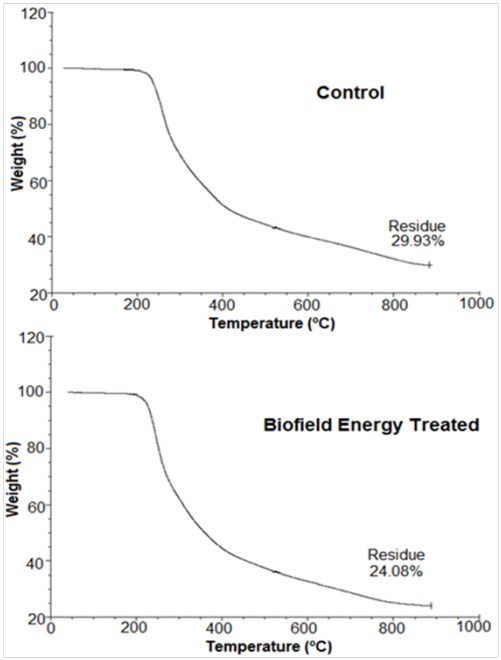

Figure 2: TGA thermograms of the control and Biofield Energy Treated sulfamethoxazole.

Table 3: TGA/DTG data of the control and Biofield Energy Treated samples of sulfamethoxazole.

Sample	TGA		DTG {T_{max} (°C)}
	Total weight loss (%)	Residue %	Peak
Control	70.07	29.93	257.57
Biofield Energy Treated	75.92	24.08	247.53
% Change	8.35	-19.55	-3.90

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

Besides, the DTG thermograms of both the control and Biofield Energy Treated samples (Figure 3) showed a single peak. The maximum degradation temperature (T_{max}) of the treated sample was also observed to be decreased by ~10°C (3.90%) compared with the control sample. Overall, the TGA / DTG studies indicated that the thermal stability of the Biofield Energy Treated sulfamethoxazole sample was reduced compared with the untreated sample.

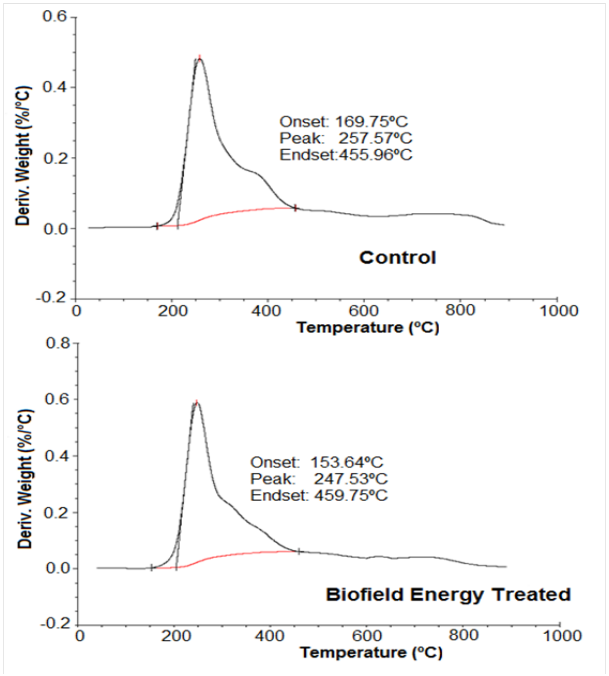

Figure 3: DTG thermograms of the control and Biofield Energy Treated sulfamethoxazole.

Differential Scanning Calorimetry (DSC) Analysis: The DSC technique was used to study the melting, crystallization and other thermal behaviour of the sulfamethoxazole sample[38]. According to literature, the DSC curve of sulfamethoxazole showed two curves, among which, the first endothermic peak at 172°C shows the process of fusion; whereas, the exothermic peak at 270°C denotes the oxidation of evolved products as observed in the form of the first mass loss in the TG curves, and may also refer to the thermal decomposition of the sample[41]. The DSC thermograms of both the samples were shown in Figure 4, and they are observed to be in concordance with the literature. The thermograms of both the samples showed a sharp endothermic peak, which is considered as the melting / fusion temperature of the samples. It was observed at 170.14°C in the control sample; whereas at 169.85°C in the Biofield Energy Treated sample. Thus, the results showed a slight reduction (0.17%) in the melting point of the Biofield Energy Treated sample compared to the control sample (Table 4). Moreover, the latent heat of fusion (ΔH) of the Biofield Energy Treated sample was found to be 136.60J / g, which was significantly increased by 10.34% compared with the ΔH of the control sample (123.80J / g).

Table 4: Comparison of DSC data between the control and Biofield Energy Treated sulfamethoxazole.

Peak	Description	Melting Point (°C)	ΔH_{fusion} (J/g)
Melting Temperature	Control sample	170.14	123.80
	Biofield Treated sample	169.85	136.60
	% Change*	-0.17	10.34
Decomposition Temperature	Control sample	271.22	681.10
	Biofield Treated sample	286.20	757.10
	% Change*	5.52	11.16

ΔH: Latent heat of fusion.

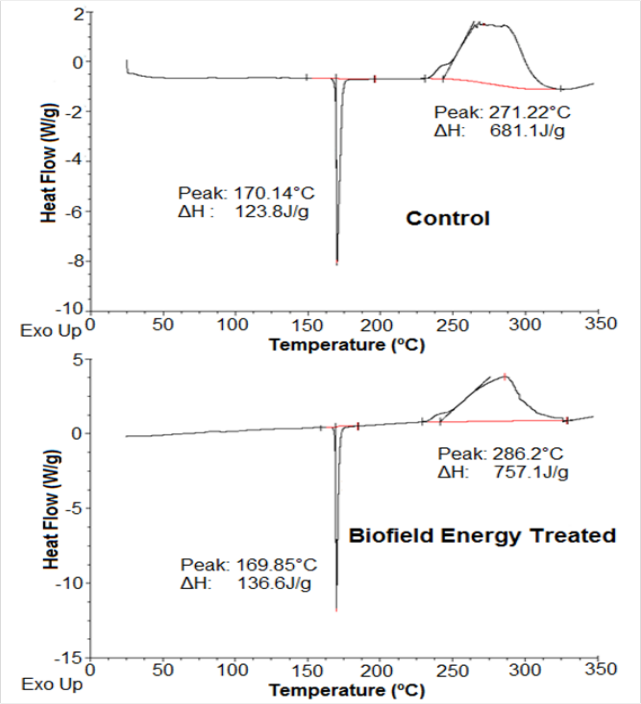

Figure 4: DSC thermograms of the control and Biofield Energy Treated sulfamethoxazole.

The DSC thermograms of the control and Biofield Energy Treated samples of sulfamethoxazole also exhibited a broad exothermic inflection at 271.22ºC and 286.20ºC, respectively, which is considered to be resulted due to oxidation of evolved products present in the sample. Furthermore, the latent heat of fusion (ΔH) corresponding to this peak was observed at 681.10 and 757.10 J/g in control and Biofield Energy Treated sample, respectively. Further, the data suggested that the Biofield Energy Treated sample showed a significant increase in this temperature (5.52%) as well as ΔH (11.16%) compared to the control sample. From the results, it was presumed that such changes might happen due to Biofield Energy treatment, which may cause some alterations in the molecular chains as well as the crystallization structure of the sulfamethoxazole[38]. Also, the changes in melting temperature and ΔH indicated the altered thermal stability of the Biofield Energy Treated sample compared to the untreated sample.

Conclusions

The study shows that the Trivedi Effect®-Consciousness Energy Healing Treatment imparts significantly on the particle size, surface area, peak intensities, crystallite size, and thermal properties of the sulfamethoxazole powder. The particle size values in the Biofield Energy Treated sample were observed to be significantly decreased by 19.71%, 6.28%, 5.40%, and 7.98% at d_{10}, d_{50}, d_{90}, and D (4,3), respectively compared to the control sample. Moreover, the specific surface area of the Biofield Energy Treated sample was significantly increased by 12.63 % compared with the untreated sample. Such alterations in the particle size may improve the dissolution and absorption parameters of the treated sample compared to the untreated sulfamethoxazole. The PXRD data showed sharp and intense peaks in the diffractograms of both the samples, thereby indicating their crystalline nature. Later on, the peak intensities of the Biofield Energy Treated sample were observed to be significantly altered in the range of -32.49% to 120.17% compared to the control sample. Also, the treated sample showed an increase in the crystallite sizes along these characteristic peaks in the range from 0.45% to 101.86% compared to the untreated sample. Overall, the average crystallite size of the Biofield Energy Treated sulfamethoxazole sample was found to be significantly increased by 33.13% compared with the control sample. The TGA study represented that the total weight loss of the Biofield Energy Treated sample was significantly increased by 12.27%; however, the residual amount was reduced by 19.54% in comparison with the control sulfamethoxazole sample. Besides, the ΔH_{fusion} was increased by 10.34% in the treated sample compared to the control sample. Also, the degradation temperature as well as the corresponding $\Delta H_{decomposition}$ of the treated sample was observed to be increased by 5.52% and 11.16%, respectively, compared to the untreated sample. The overall results concluded that the Trivedi Effect® might create a new polymorphic form of sulfamethoxazole that might show better solubility, dissolution, absorption, and bioavailability compared with the untreated sample. The Consciousness Energy Healing Treated sulfamethoxazole may also found to be suitable for better prevention and treatment of various diseases such as urinary tract infections, ear infections, traveler's diarrhea, shigellosis, bronchitis, and *Pneumocystis jiroveci* pneumonia, 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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