

Wormwood Cigars (Moxa-Rolls)- A Natural Generator of Microwave Radiation

Yanenko OP^{1*}, Golovchanskyi OM², Golovchanska OD², and Shevchenko KL¹

¹National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute "Kyiv, Ukraine

²Bogomolets National Medical University Kyiv, Ukraine

*Corresponding author: Yanenko O, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute "Kyiv, Ukraine; E-mail: op291@meta.ua

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Abstract

The article presents the results of a study of the microwave parameters of the thermal state of moxa for moxibustion. The theoretical and physical basis of such research is described. Information is presented on research objects - moxa-rolls of different compositions and manufacturers. The characteristics and description of the unique radiometric equipment and research methodology are given. As a result of experimental measurements, it became clear that smoldering cigars (moxa-rolls) generate not only infrared, but also microwave radiation. At the same time, the level of microwave radiation is almost 100 times higher than the level of human radiation, which creates an additional therapeutic effect. It was established that cigars of different brands and with different additional fillings have the same level of radiation. The conducted studies allow us to assert the possible complex effect on the patient of both the thermal and microwave components of the output signal of the wormwood cigar (moxa). The mechanism of action of the entire spectrum of moxa radiation requires a deeper study, from the point of view of evidence-based medicine for use in the medical practice.

Keywords: Moxa, Moxa-rolls (wormwood cigars), Microwave radiation, Infrared radiation, Power, Radiometer.

1. Introduction

It is known that traditional Chinese medicine (TCM) widely uses the heating of acupuncture points with the help of smoldering moxa (specially processed wormwood, *Artemisia argyi*), in the form of cigars or rolls, the so-called jiu therapy (jiu, moxibustion). The therapeutic effect of warming acupuncture points is associated with thermal effects, radiation effects, pharmacological effects of moxa and its combustion products [1].

The spectral density power of thermal energy of the infrared range emitted by moxa can be determined by Planck's formula

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$$G(f, T) = rhf \left[\frac{1}{\exp(hf/kT) - 1} + \frac{1}{2} \right] \quad (1)$$

where G – spectral density of radiation power (SDRP) on the frequency f ; β – coefficient of emissivity (greyness) of the object; c – speed of EMR propagation in vacuum; k – Boltzmann constant ($1,38 \cdot 10^{-23}$ W/Hz); T – thermodynamic temperature of the object.

At the same time, it is known from the course of physics that heated dielectric bodies emit signals in a wide range of frequencies, and therefore it can be assumed that the radiation of smoldering moxa also occurs at frequencies in the millimeter (mm) range. It is considered that the radiation of the mm part of the microwave range has a significant impact on the course of processes in a living organism [2], [3]. The indicated range was chosen by the authors for research because microwave, millimeter, information-wave therapy with low-intensity signals is sufficiently known and widely implemented by hardware devices [4]- [6].

To estimate the spectral density in the mm range, expression (1) is simplified to the Rayleigh-Jeans formula

$$G(f, T) = \beta \frac{2\pi \cdot f^2}{c^2} kT \quad (2)$$

where G – spectral density of radiation power (SDRP) on the frequency f ; β – coefficient of emissivity (greyness) of the object; c – speed of EMR propagation in vacuum; k – Boltzmann constant ($1,38 \cdot 10^{-23}$ W/Hz); T – thermodynamic temperature of the object.

Usually, in experimental studies, measuring equipment has some limitations in terms of frequency range and bandwidth of analysis. When performing measurements in the mm range, using a radiometric system at the selected frequency and analysis band, the integral power is determined, which can also be calculated using the Nyquist formula, knowing the temperature of the object:

$$P = G(f, T) \Delta f = \beta kT \Delta f, \quad (3)$$

where P – integral power of the emission, Δf – analysis band (measurement)

Thus, using formulas 1-3, it is possible to combine instrumental measurements with theoretical calculations to confirm the objectivity of experimental studies.

The task of the research was formed by the assumption that, since wormwood cigarettes (moxa rolls) are dielectrics, when they burn (smolder), radiation occurs not only in the infrared, but also in the millimeter spectrum.

The purpose of this work is: determination of the presence and assessment of the power level of electromagnetic radiation (EMR) in the millimeter range, as well as monitoring of the dynamics of radiation power in the infrared and millimeter spectra of wormwood cigars (moxa rolls) of different manufacturers and different compositions.

2. Peculiarities of Moxibustion (Jiu Therapy)

Today, it is believed that the main therapeutic factor of moxibustion is EMR of the infrared range (IR) - electromagnetic radiation covering the spectral region between the red limit of visible light with a wavelength of $\lambda = 760$ nm, short-wave (up to 1000 nm) and long-wave IR (up to 1500 nm) radiation. It is noted that the radiation spectrum of smoldering moxa ranges from 0.8 to 5.6 μm ; the peak is about 1.5 μm , and lies in the near-infrared (NIR) part of the spectrum [7]. According to literary sources, the temperature of smoldering moxa roll can reach 548–890°C [8], [9].

In TCM, moxa is used in the form of wormwood cigars (moxa rolls) and wormwood cones. Considering certain difficulties in researching the effect of wormwood cones, the authors focused on studying the properties of wormwood cigars (moxa rolls). To make moxa rolls, wormwood is used, which can be kept under certain conditions for up to 10 years.

According to the ideas of TCM, moxa has the property of "warming and drying" the human body. Moxibustion (warming acupuncture points with smoldering moxa) warms the channels and dissipates the cold; strengthens Yang energy; disperses blood stagnation, as well as stagnation in energy channels; prevents disease and supports general health [10]. The composition of wormwood cigarettes, in addition to moxa itself, may include other components that modify the therapeutic effect of moxa therapy and cause special indications for their use.

3. Description of Research Objects

9 wormwood cigars (moxa rolls) of different manufacturers were prepared and used for experimental research. All cigars were stored in standard conditions (dry place, temperature 18-22 °C). Cigar size, except cigar №3: diameter 18 mm, length 200 mm (± 1 mm). Cigar №3 size: diameter 50 mm, length 150 mm.

Researched objects:

№1 cigar «Wenjiuchunaitiaopureroll» – pure wormwood;

№2 cigar «Shinianchenai» – wormwood aged for 10 years; additional components: Ginseng, Salvia miltiorrhiza, Ligusticum, Chuanxiong, Lycium chinense, Schisandra chinensis, Ganoderma lucidum, Angelica sinensis, Leonurus heterophyllus, Poria cocos, Notopterygium incisum;

№3 cigar «Leihuoshenzhen» - wormwood and additional components: saffron, frankincense, myrrh, Agilawood, agastache, radix Angelicae, Notopterygium incisum, rhizome Zingiberis, rosin;

№4 cigar «Yaoaitiao» - wormwood; additional components: Cassia, Alpinia officinalis, Pogostemon cablin, Dalbergia, Dauriacanthus, dried orange peel, Salvia miltiorrhiza, Shengchuanniao;

№5 cigar «Qingaitiao» – pure wormwood;

№6 cigar «Qiaitiao» - pure wormwood;

№7 cigar «Xiangai» - pure wormwood aged for 7 years;

№8 cigar «Nienyingyaotiao» - pure wormwood;

№9 cigar «Yaoyongjiutiao» - pure wormwood; additional components: realgar, Angelica Dahurica;

№10 a tobacco cigarette without a filter.

4. Technical Support and Research Procedure

Experimental studies of the selected samples were carried out in the laboratory of microwave radiometry and microwave measurements of the radio engineering faculty of the Igor Sikorskyi National Technical University of Ukraine.

A highly sensitive radiometric system “HY—2” certified by the State Standard of Ukraine was used to measure the parameters of microwave signals. This system has the following technical characteristics:

- operating frequency range 37-53 GHz;
- analysis strip 10^8 Hz;
- fluctuation sensitivity $1 \cdot 10^{-14}$ W.

The measurement was carried out at the average frequency (43 GHz) of the operating range of the radiometric system (RS) for 210 seconds. Before conducting the moxa rolls study, the EMR power level of the central zone of the palm of three respondents was measured, the average value of which at a frequency of 43 GHz was $4,0 \cdot 10^{-13}$ W. The calculated level of radiation power of the human body, determined by formula (3), at a temperature of 310 K and values of the emissivity coefficient from 1.0 to 0.5, is in the range from $4.2 \cdot 10^{-13}$ W to $2.1 \cdot 10^{-13}$ W, which is close to the measured experimental value. The body gray factor determined from experimental data is 0.9.

Fig. 1 shows the placement of moxa for measurement. A smoldering wormwood cigar (moxa-roll) was placed in the center of the receiving antenna of the radiometric system during the measurement, at a distance that excluded heating of the antenna. Measurement of the EMR power of wormwood moxa rolls was carried out in relation to the established average level of radiation of the human body.



Fig.1. Photo of the input part of the RS and placement of moxa-rolls for measuring EMR in the millimeter range.

In fact, the excess power of smoldering moxa rolls over the power of human EMR, which can have a therapeutic effect on the body, was measured. The excess was recorded by the measuring attenuator, which reduced the level of the smoldering moxa signal to this value. The obtained values are presented in the Table 1.

Table 1: The EMR in the Millimeter Range Value Measurement of Smoldering Moxa Rolls.

Nº	Object	Excess human EMR level (dB)	Absolute value of EMR excess (W)
1.	Nº1	18,45	$1,40 \cdot 10^{-11}$
2.	Nº2	19,0	$1,58 \cdot 10^{-11}$
3.	Nº3	19,8;	$1,91 \cdot 10^{-11}$
4.	Nº4	18,6	$1,44 \cdot 10^{-11}$
5.	Nº5	18,55	$1,42 \cdot 10^{-11}$
6.	Nº6	18,45	$1,40 \cdot 10^{-11}$
7.	Nº7	18,45	$1,40 \cdot 10^{-11}$
8.	Nº8	18,5	$1,42 \cdot 10^{-11}$
9.	Nº 9	21,8	$3,02 \cdot 10^{-11}$
10.	Nº10	16,75	$0,94 \cdot 10^{-11}$

The average excess of the signal power of a smoldering wormwood cigar above the level of radiation of the human body at a frequency of 43 GHz is 19.07 ± 1.12 dB or $1.67 \pm 0.53 \cdot 10^{-11}$ W. The radiation power did not change during the measurement time (210 seconds), although a "cap" of ash is formed on the smoldering moxa cigarette (Table 2). An ordinary tobacco cigarette with a smaller radiation area has an excess power of 16.75 dB, and a power level of $0.94 \cdot 10^{-11}$ W.

Table 2: Monitoring of the Stability of the Microwave EMF Power of Smoldering Moxa-roll No. 6.

Time (sec)	1	30	60	90	120	180	210
Power (W)	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$	$1,4 \cdot 10^{-11}$

The authors also investigated the dynamics of changes in the output power of the IR flow of smoldering moxa-rolls over time. The OM3-65 absorbing power wattmeter was used for measurement, in the wavelength range of 0.8-1.0 μ m (Fig.2).



Fig. 2. Photo of the stand for evaluating the power of IR radiation of smoldering moxa rolls.

The results of measurements of changes in the power of IR radiation of smoldering mox-roll No. 6 at a distance of 20 mm from the detector are presented in Table 3, as well as in Fig. 3.

Table 3: Monitoring of Changes in the Power of IR Radiation Smoldering Moxa roll №6.

Time (sec)	Power (10 ⁻⁴ W)	Time (sec)	Power (10 ⁻⁴ W)	Time (sec)	Power (10 ⁻⁴ W)
1	1,6	13	0,9	120	0,1
2	1,5	14	0,9	145	0,23
3	1,6	15	0,8	156	0,2
4	1,9	19	0,7	163	0,19
5	1,4	29	0,7	169	0,18
6	1,5	32	0,6	172	0,17
7	1,4	36	0,5	178	0,16
8	1,2	52	0,4	180	0,15
9	1,1	71	0,3	193	0,14
10	1,2	83	0,2	199	0,13
11	1,1	93	0,2	210	0,12
12	1	105	0,1		

It was found that the power of the IR flow due to the formation of a "cap" of ash during the smoldering of the moxa-roll in 210 seconds. decreased by more than an order of magnitude, from $1,6 \cdot 10^2 \mu\text{W}$ to $0,12 \cdot 10^2 \mu\text{W}$.

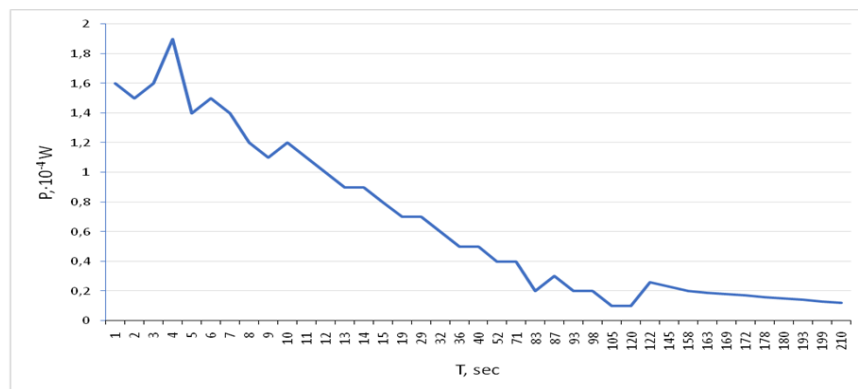


Fig. 3. The dynamics of changes in the IR radiation power of smoldering moxa-roll No. 6 over time.

At the same time, measuring the power of the microwave flow using a radiometric system, in 210 seconds, fixed the constant values shown in Table 2.

5. Conclusions

- Wormwood cigars (moxa-rolls) emit radiation in the millimeter range when smoldering. At a frequency of 43 GHz, the level of microwave radiation is almost 100 times higher than the level of human radiation. Moxa-rolls are a natural generator of broadband microwave radiation.
- At the frequency 43 GHz the power of the mm-Wave radiation of the smoldering moxa-roll is stable for the testing 210 seconds.

- It has been established that, regardless of the manufacturer and composition of wormwood cigars, the power of microwave radiation does not differ significantly.
- The power of infrared radiation from smoldering moxa cigars decreases over time due to absorption by the ash.
- The conducted studies allow us to state that the therapeutic effect of moxa-therapy on the patient is due to the complex action of infrared and microwave components. It can be assumed that the main therapeutic effect of moxibustion is due precisely to millimeter radiation.
- The mechanism of action of the entire spectrum of smoldering moxa radiation requires a deeper study from the point of view of evidence-based medicine for use in medical practice.

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