Original Article

The electroenterographic findings of the aqueous extract of betalains in adult patients with intestinal hypermotility disorders

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ABSTRACT

Intestinal mobility disorders are either hypo or hypermotility conditions that affect the gastrointestinal tract due to smooth muscle or neuronal disorders. Betalains are good candidates to be evaluated for their intestinal modulating properties since they may have a higher safety index and pleiotropic efficacy. In this small sample, clinical trials (N = 26 cases of motility disorders), fasting, and betalains intake cases of motility disorders had been measured for their electro enterography EEnG at 8:00 am. Betalains intake cases were given oral doses of 12 mg/kg betalains extract 30 minutes before measurements. A biosignal interface was used (UNO, Italy) and the driver was installed within the Simulink R2021b block with the use of a lowpass filter to cancel ECG wave interference. The participant's privacy, autonomy, and information about the use of this habitually used beetroot extract were insured and verbally explained regarding the purpose of the study, the method, and the time of analysis. The results have clearly shown that the oral administration of the aqueous extract of betalains achieved mild antispasmodic effects in cases with intestinal hypermotility disorders by decreasing the maximum force of contraction as had been indicated by EEnG reduction in the mean amplitude difference from 1.25 micV to 1.07 micV. Moreover, betalains caused EEnG frequency to decline from 21.5 MHz to 18.5 MHz. These effects were mild although statistically significant (P = 0.04). The oral dose of 12 mg/kg of betalains aqueous extract showed mild but significant intestinal relaxing effects in patients with intestinal hypermotility disorders.

Keywords: Betalains, Electroenterography, EEnG, Motility disorders, Aqueous extract, Relaxant

Introduction

Intestinal motility disorders are abnormal muscle and nerve disorders that cause spasms or lack of motion anywhere along your gastrointestinal tract [1, 2].

Many epidemiological studies showed that 30 million Americans have intestinal motility disorders. A worldwide prevalence of 30%-45% of all gastrointestinal conditions is attributed to intestinal motility disorders [3].

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Majeed SA, Qassam H, Mohammad AR, Hassan ES, Gaen KK, Zamil ST, et al. The electroenterographic findings of the aqueous extract of betalains in adult patients with intestinal hypermotility disorders. J Adv Pharm Educ Res. 2024;14(2):72-6. https://doi.org/10.51847/mCQGAktfCH

There are several types and causes of motility disorders including neuropsychiatric disorders, irritable bowel disease, intestinal pseudo-obstruction, colon inertia, scleroderma, amyloidosis, spinal muscular atrophy, short intestine syndrome, lactose and fructose intolerance, small intestinal overgrowth bacteria and fungi and megacolon [4-6].

Studies concerning assessing new drug options for treating intestinal motility disorders are not sufficient. Precisely intestinal motility disorders require drugs with pleiotropic mechanisms and a broad spectrum of safety since such disorders are chronic events and are attributed to multiple pathogeneses. Phytochemicals are reasonable options to be evaluated for their intestinal modulating properties since phytochemicals may possess a higher safety index and pleiotropic efficacy [7].

Of this candidate, phytochemicals are the betalains. Subfractionation of betalains was conducted in aqueous phase extraction. Betalains were separated from the polymer employing organic–aqueous extraction resulting in 3.4 fold increase in concentration [8]. All the betalains are categorized

into two groups according to their color: the betacyanins (purple reddish) and the betaxanthins (yellow orangish). Betanin and indicaxanthin are the major constituents for each category. Oral intake of 500 grams of cactus pear caused peak plasma betalain concentrations after 3 hours and was detected within 1 hour. The half-life for betanin was (0.94+/-0.07 hours) and that of indicaxanthin was (2.36+/-0.17 hours) [9].

The study's purpose

To extract the betalains compounds from beetroots and to assess the influence of oral betalains on the electroenterographic findings in intestinal motility disorders patients

Materials and Methods

Samples and the study design

This study was designed as a small sample clinical trial. The sample size included 26 recorded cases (13 control; 4 females and 9 males and 13 betalains oral intake; 5 females and 8 males), the mean body weight was 72 kg, and the mean age was 48 years. The patients were enrolled according to communication with friends and relatives in Al-Najaf Governorate/ Iraq during the period between 1/9/ 2022 and 21/10/2022. The participant's privacy, autonomy, and information about the use of this habitually used beetroot extract were insured and verbally explained regarding the purpose of the study, the method, and the time of analysis in addition to the recommendation of remaining fast until the measurements are conducted. Their intestinal motility disorders were defined according to the reports of their doctors and the suggestions made by the specialists in abdominal ultrasounds.

Fasting and betalains administered measurements of electro enterography EEnG were carried out at 8:00 am. Betalains intake cases were given oral doses of 12 mg/kg betalains extract 30 minutes before measurements.

A biosignal interface was used (UNO, Italy) and the driver was installed within the Simulink R2021b block with the implementation of a lowpass filter to avoid ECG wave interference. The rubber carbon skin electrodes were placed just to the right of the umbilicus. The com electrodes were placed on the upper right thigh with a conductive gel. The patients were instructed to breathe normally and quietly to avoid muscle EMG wave interference.

Data were recorded for each patient and stored for analysis. These data were constituted of the EEnG statistics, transitions, and cycles to analyze EEnG frequency, duration, and amplitude and correlate them with the corresponding functional events of the intestinal wall muscles and nerves.

Betalains extraction

Betalains were extracted with pure water or aqueous solvents. Raw beetroots of Beta vulgaris L., Rhonda type were collected from the local supermarket and cleaned to remove dust and debris and then peeled with a sharp knife manually. The peels were then stirred in a mixer for 2 minutes to attain the pulp. That pulp (415 g) was mixed with (15%) deionized distilled water solvent ratios (415g, 1 L w/v). A thermostat water bath maintained the temperature at 80 °C for 30 minutes with stirring at 20 r.p.m. The extracted juices were then filtered through a micropore hemicellulose filter under a pressure of 0.4 kg/cm². The resultant product was centrifuged for 5 minutes at 6000 r.p.m., the colored supernatant was collected and kept under 4 °C refrigeration before UV-visible spectrophotometry analysis at 535 nm for betacyanin and 480 nm for betaxanthin to determine the concentrations and calculating the human dose required for each patient [10].

Results and Discussion

The results showed the estimated UV-visible spectrophotometric absorbance of different types of the aqueous extracted betalains betacyanins at 480 nm and betaxanthins at 535 nm. The values indicate more than 90% of purity of the used betalains whichhat is used to estimate the oral dose of 12 mg/kg, **Figure 1**. The aqueous extract contains several types of these betalains. This spectrophotometric estimate the percentage of the total betalains contents within this extract which was up to 90% purity. This level of betalains purity meets the goal of this study by testing the total amount of all betalains against intestinal electric activity.

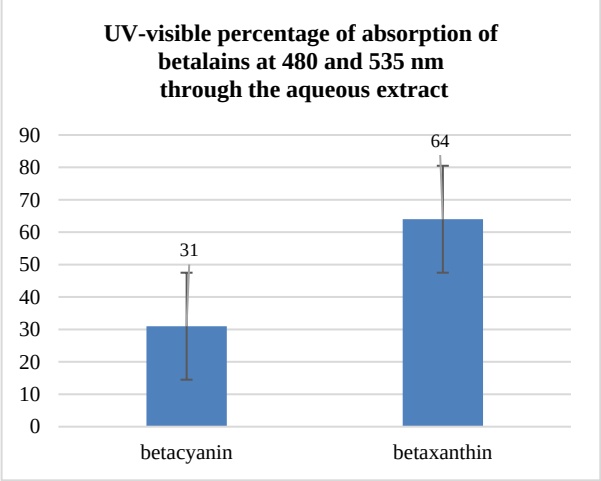
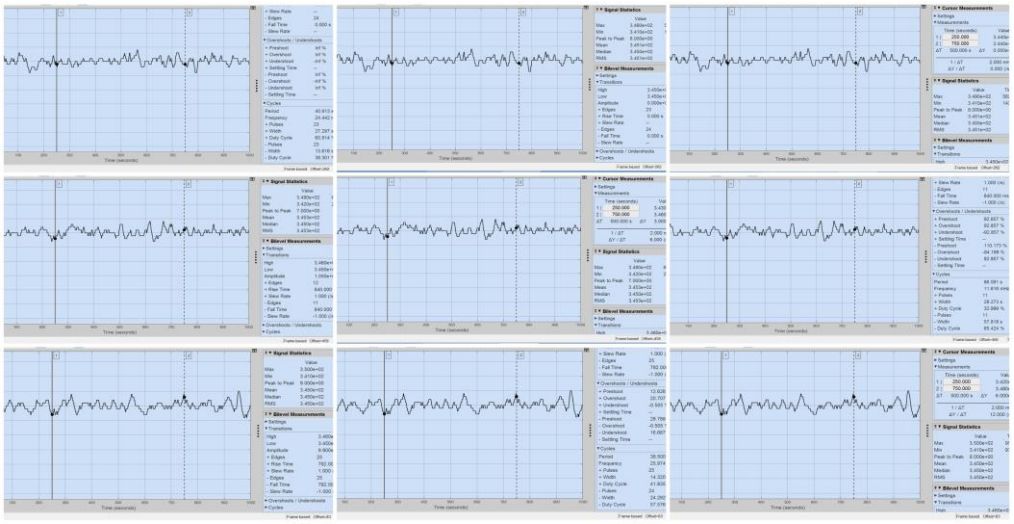


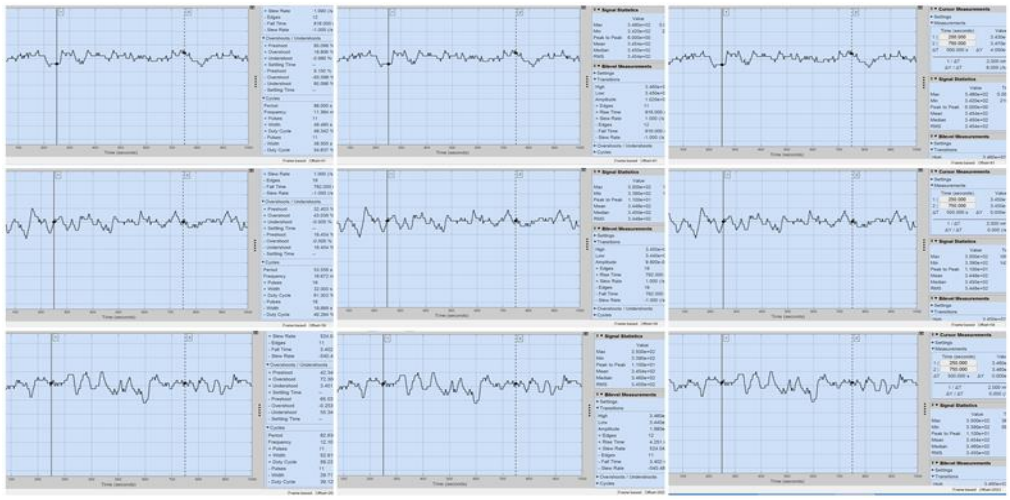
Figure 1. Percentages of absorption of betalains measured at 480 nm and 535 nm.

The electro enterographic findings

The study revealed a montage of the EEnG records for the control **(Figure 2a)** cases and the betalains intake cases **(Figure 2b)**. Electroenterographic findings included EEnG wave statistics, transitions, and cycles parameters that are used later on to evaluate betalains relaxant effects, **Table 1**.



a)



b)

Figure 2. The montage of the EEnG records

Table 1 involves the main EEnG parameters used to assess betalains' influence on intestinal motility. The maximum force of intestinal contractions may be the function of the amplitude of the EEnG signal. The wave frequency also refers to the peristaltic waves. The duty percent is the time during which the intestines are electrically active throughout the measurement period.

Table 1. The main EEnG parameters used to assess betalains' influence on intestinal motility.

EEnG parameters	Values for control cases (intestinal motility disorders at fasting)	SD	Values for betalains treated cases	SD	P value
Mean EEnG difference in signal amplitude in micV	1.25	+/- 0.1	1.07	+/- 0.2	0.04
Mean pulse period (in s) from rising and fall time	1.58	+/- 0.2	1.63	+/- 0.3	0.03
Mean EEnG wave frequency in MHz	21.5	+/- 1.3	18.5	+/- 1	0.04
EEnG mean duty% (intestinal activity%)	98.4	+/- 1	99.2	+/- 1	0.8 (not sig)

Effect of betalains on intestinal motility disorders

The data showed that betalains consumption resulted in a marked reduction in mean amplitude values measured in minV as compared to control cases, **Figure 3**. The reduction in the amplitude of the intestinal EEnG was from 1.25 micV (+/- 0.1 micV) to 1.07 micV (+/- 0.2 micV) for the control untreated group of intestinal motility disorders versus betalains treated cases, (P = 0.04). This amplitude value refers to the maximum force and contraction of intestinal muscles suggesting that betalains can be of benefit to patients with hypermotility conditions.

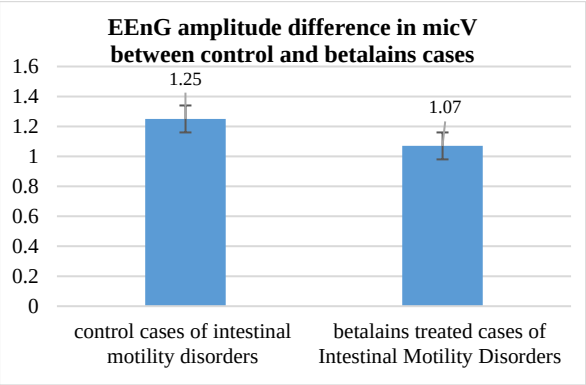


Figure 3. The difference in mean amplitude values (in micV) between the control cases and betalains treated cases.

Effect of betalains intake on EEnG pulse period

The result reveled the betalains intake prolonged the activity state of the intestine per each contraction measured in seconds in comparison with the control cases, **Figure 4**.

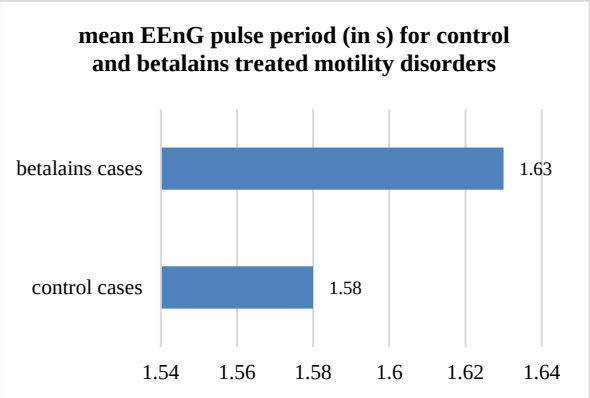


Figure 4. Themean duration of the intestinal EEnG pulse (in s) estimated by the pulse rise and fall times.

Effect of betalains consumption on times of peristaltic movements

The current study shows that betalains-treated group reduced the wave frequencies measured in MHz and increased activity of intestine during the time of measurement as compared with the control cases, **Figures 5 and 6**.

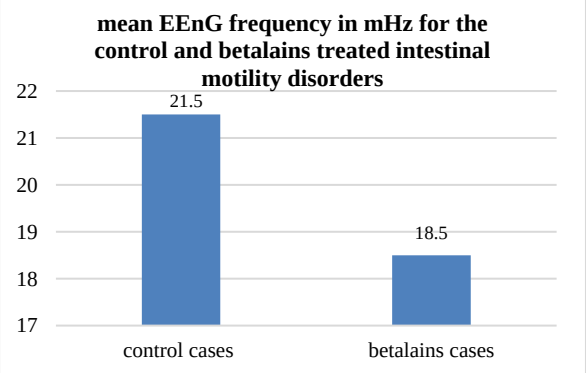


Figure 5. The wave frequency (in MHz) indicates the times of the intestinal peristaltic movements.

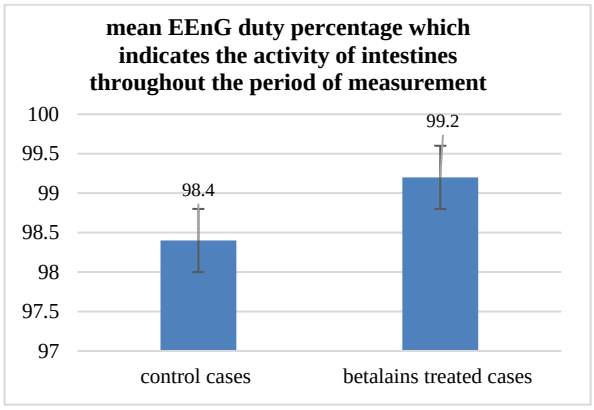


Figure 6. the duty percent of the EEnG wave is the time during which the intestines are electrically active throughout the measurement period.

Motility disorders of the intestines are real health, social, and even economic problems since such disorders will tremendously deteriorate human activity [11].

On the other hand, intestinal motility disorders are tending to be chronic and have multiple predisposing and precipitating factors rendering them requiring prolonged monitoring and treatments [12].

Cheap, relatively safe, and effective treatment options are urgently required to be assessed on a wide scale of compounds that are characterized by the mentioned properties [13]. Phytochemicals are good candidates for intestinal motility disorders owing to their antioxidant [14], anti-inflammatory, and antimicrobial activity [15].

Betalains are the hydrophilic constituents of beetroot which is commonly used as a diet item and colorant [16, 17].

In this study, it was clear that oral administration of the aqueous extract of betalains achieved mild antispastic effects in cases with intestinal motility disorders by decreasing the maximum force of contraction as had been indicated by EEnG decrease in mean amplitude difference from 1.25 micV to 1.07 micV. Moreover, betalains caused EEnG frequency to decline from 21.5 MHz to 18.5 MHz. These effects were mild although statistically significant ($P = 0.04$).

There were no significant changes between the control cases of intestinal motility disorders and betalains treated cases regarding the percentage of the activity of the intestinal tone out of the period of measurement as indicated by the EEnG duty percentage.

Few studies suggested the relaxant effects of betalains in the intestines of healthy individuals and animals [15, 18-20].

Further enrollment of patients with intestinal motility disorders is recommended to be treated with the aqueous extract of betalains for extracting accurate clinical evidence about the benefits of betalains in motility disorders in comparison with the standard treatments.

Conclusion

From the overall results, the oral dose of 12 mg/kg of betalains aqueous extract showed mild but significant intestinal relaxing

effects in patients with intestinal hypermotility disorders as indicated with electroenterography.
All authors have contributed equally.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: All procedures were performed in compliance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The current study has been approved by the ethics committee of the Faculty of Medicine, University of Kufa.

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