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Egyptian Batata (Sweet Potato: *Ipomoea batatas Lam.*) Juice as a Functional Food to Relieve Acid Reflux and Dyspepsia

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ABSTRACT

In Europe, use of potatoes (Solani tuberosi tuberecens) is a traditional remedy for stomach complaints. But in Egypt, uses of sweet potato (Batata) juice as a functional juice relieve acid reflux and dyspepsia. We performed a pilot study on the effectiveness and tolerability of freshly squeezed Batata juice in patients suffering from dyspeptic symptoms. Results production of Batata juice by thermal and pasteurization methods indicated that the Total chlorophyll (Chl.A and Chl.B), total carotenoids, antioxidant activity-DPPH, total phenols and vitamin C were decreased in pasteurized Batata juice compared with fresh Batata juice. After informed written consent, a total of 12 male subjects with various dyspeptic symptoms were enrolled, to drink about 100 ml of juice two times per day and whenever dyspeptic symptoms appeared for two weeks. Validated outcome measures included the gastrointestinal symptom (GIS) profile, a disease-specific health assessment questionnaire (QOLRAD). The GIS profile showed a high significant improvement in symptoms especially for nausea (3.2 ± 0.09) to (2.3 ± 0.87), abdominal cramps (2.9 ± 08) to (2.3 ± 0.7), heart burn (2.9 ± 0.78) to (1.5 ± 1.0) and retrosternal discomfort (2.8± 0.6) to (2.5 ± 0.6). Episodes of sickness, vomiting, bloating, epigastric pain, loss of appetite and early satiety were also significantly improved.

Keywords: sweet potato, batata, juice, acid reflux, dyspepsia, disease

Introduction:

Sweet potato (*Ipomoea batatas Lam.*) is a root vegetable which belongs to the family of Convolvulacea. Sweet potato is cultivated extensively for its nutritious and health-promoting values (1,2) and also plays an important role in food security. Sweet potato often considered as an "almost perfectly nourishing food", contains vitamins, iron, calcium, zinc, proteins, minerals, and many other nutrients at favorable ratios (3,4). Heartburn is a popular term used to signify that acid from the stomach is causing irritation of the lower esophagus. This is attributed to the reflux of strong acid released by the stomach after meals, simply as the sphincter at the lower end of the stomach opens too much or not closing tight stomach acid will seep back into the esophagus causing burning pain and patients will complain of a heart burn (5). Symptoms of heartburn are characterized one or more of the following; a burning sensation in the epigastrium, acidic taste in the mouth, coughing, hoarseness of voice, bad mouth odor, feeling sick and worsening of symptoms after eating, or when lying down (6). Causes of heartburn may be related to certain foods and drinks such as coffee, alcohol, chocolate and fatty or spicy foods. Overweight, smoking, pregnancy, stress, anxiety, NSAID agents (7). Usual treatment of heartburn includes antacids, prescribed to neutralize acid in the stomach these however, have a High-dose calcium and sodium bicarbonate which when taken together may cause nausea, weakness, irritability and hypercalcemia (8). H-2-receptor antagonists, prescribed to reduce stomach acid, their side effects vary from diarrhea, dizziness, rashes, headaches, and gynecomastia (9). Proton pump inhibitors, their long-term use is associated with Pneumonia, Chronic disease of the kidney, Micronutrient deficiencies and gastrointestinal neoplasms (10). Although these drugs have reduced morbidity rates, regretfully they also produce many adverse effects including recurrence of the disease, and are usually too expensive for the common people (11,12). Given the above facts, it is imperative to find a natural remedy from local foods or plants that may have the potential to

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neutralize gastric acid. Health organizations around the world are becoming more dependent on natural products for primary health care as a first line of treatment; this is due to fewer side effects of these products as compared to synthetically produced drugs, (13, 14, 15). Sweet potato (*Ipomoea batatas L.*), is grown widely in warm temperate regions in Egypt. The tubers of *Ipomoea batatas L.* are commonly known as sweet potato. Previous reports on sweet potato have claimed that it posses anti-oxidant, wound healing and anti-bacterial properties (16, 17, 18).

Dyspepsia and acid reflux and could be treated by sweet potatoes. This is explained by the fact that starchy vegetables are alkaline, this means they help counteract the acid in the stomach that contributes to acid reflux and heartburn. According to Koufman et al., (19) they can act as a remedy for acid reflux because of the complex carbohydrates, they contain which is thought to help soothe the stomach and prevent acid from traveling back up into the esophagus.

The sweet potato chemical composition was done culinary and nutritional quality important, depend these on agriculture and agronomic conditions. Protein content in sweet potato was 1% - 2% and it has high lysine content, resulting in high biological value, whereas fat content was reduced (0.1 - 0.4%) (20,21). Other chemical components in sweet potato were pigments, antioxidant and vitamins (β-carotene, phenolic acid, vitamin B, C, E) (22, 23, 24) which is good energy (111 kcal/100g) providers (22).

Too little literatures were available on the manufacture of sweet potato (Batata) juice. So the objective of this research was to evaluate the production of traditional to produce healthy juice and maintaining with delicious taste / flavor (Batata juice) by heated temperature and pasteurization, at the same time freshly color, texture, flavor and taste juice. Antioxidant activities, phenolic compounds, total carotenoids, vitamin C and sensory characteristics were studied.

This research aims to produce sweet potato (Batata) juice with a special and delicious taste using a thermal method and pasteurization, which causes the characteristic taste of sweet potato (Batata) juice, on the properties of sensory evaluation, phenolic compounds, antioxidant activities, vitamin C and total carotenoids of sweet potato (Batata) juice.

The objective of this research was to evaluate the production of traditional sweet potato (Batata) juice to produce healthy juice and maintaining with delicious taste / flavor (Batata juice) by heated temperature and pasteurization, at the same time freshly color, texture, taste and flavor juice. Bio-Active Constituents like: antioxidant activities, total phenolic compounds, total carotenoids and vitamin C were studied. Also, this research aims to produce sweet potato (Batata) juice with a special and delicious taste using a thermal method and pasteurization, and to study its effectiveness as a remedy for acid reflux and prevent acid from traveling back up into the esophagus.

Material and Methods:

Raw materials:

The fully matured, freshly harvested sweet potato vegetable (Superstar cultivar) provided by the local market, Cairo, Egypt. Sweet potato (*Ipomoea batatas Lam.*) obtained from field experimental in institute of agronomy crops at Agricultural Research Institute, Giza, Egypt. Sweet potato (*Ipomoea batatas Lam.*) vegetable samples were used for all processing trials and was stored at 4 ^{o}C after receipt and processed within 24h.

Preparation and extraction of sweet potato (Batata) juice):

Sweet potatoes were washed, weighed, knife peeled and cut into smaller pieces and immersed into 1% sodium meta-bisulfite solution (So_2). They were rinsed with water and homogenized with the help of blender. Batata juice was extract and heated to a temperature of 60°C and maintained at that temperature for 2 hours. The Batata juice was then strained with cheesecloth. It was then pasteurized at 85°C for 25min and bottled hot. The bottled juice was cooled under running cold water and stored at room temperature for analysis (Figure-1).

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Flow Chart for sweet potato (Batata) juice Preparation

Sweet potato pieces peeled
↓
Immersed in 1% so_2
↓
Rinse and homogenize
↓
Batata juice extraction
↓
Heating at 60 ^{o}C for 2hours
↓
Strained with cheesecloth
↓
Pasteurization at 85°C for 25min
↓
Packing (filled the hot juice into clean, dry sterilized bottles)
↓
Cooling, Capping and Storage (at ambient temperature 4 ^{0}C)

Figure 1: Flow char or steps in the preparation and extraction of sweet potato (Batata juice).

Chemical analysis:

Vitamin C determination:

Vitamin C was analyzed using the **A.O.A.C.** method (25). The titrant was prepared with 50 mg of 2, 6-dichloroindophenol Na salt and 42 mg of sodium bicarbonate in 50 mL of water. The solution was diluted to 200 mL with distilled water. The extracting solution was prepared with 15 g of meta-phosphoric acid and 40 mL of acetic acid and then diluted to 500 mL with distilled water. Solutions were stored in amber bottles at 4°C. A 100 mL aliquot of untreated and treated sweet potatoes (Batata) juice was added to 100 mL of the extracting solution and then filtered using a No.1 filter paper (Whatman, Maidstone, England). The solution was then titrated with the titrant until the solution turned bright pink for at least 5 s. A standard curve was created using pure ascorbic acid (Sigma Aldrich, St. Louis, MO). Vitamin C retention was calculated using equation (1).

$$\text{Retention (\%)} = \frac{\text{mg ascorbic aci /100mL juice after treatment}}{\text{mg ascorbic acid /100mL juice before treatment}} \times 1\,00 \quad \ldots\ldots\ldots\ldots (1)$$

Determination of total phenolic content:

The total phenolic content was determined according to the Folin-Ciocalteu procedure (26). Briefly, the extract (100 µL) was transferred into a test tube and the volume adjusted to 3.5 mL with distilled water and oxidized with the addition of 250 µL of Folin-Ciocalteau reagent. After 5 min, the mixture was neutralized with 1.25 mL of 20% aqueous sodium carbonate (Na_2CO_3) solution. After 40 min, the absorbance was measured at 725 nm against the solvent blank. The total phenolic content was determined by means of a calibration curve prepared with gallic acid, and expressed as milligrams of gallic acid equivalent (mg GAE) per g of sample. Additional dilution was done if the absorbance value measured was over the linear range of the standard curve.

Determination of radical DPPH scavenging activity:

Free radical scavenging capacity of extracts were determined using the stable DPPH* according to **Hwang and Do Thi** (27). The final concentration was 200 µM for DPPH* and the final reaction volume was 3.0 mL. The absorbance was measured at 517 nm against a

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blank of pure methanol after 60 min of incubation in a dark condition. Percent inhibition of the DPPH free radical was calculated by the following equation (2):

Inhibition (%) = 100 × [(Acontrol-Asample)/Acontrol]…… (2)

Where:

A control is the absorbance of the control reaction (containing all reagents except the test compound). A sample is the absorbance with the test compound.

Determination total chlorophylls (chl.A and chl.B) and carotenoids:

The method described by **Wettestein** (28) was used for the determination of total carotenoids and chlorophylls (chl. A and chl. B) expressed as mg/L.

Human Experiment:

Subjects and Methods:

A total of 12 male subjects aged 28 - 65 who had self-reported heartburn for at least three times a week for duration of at least 2 months and did not receive prescribed treatment for heartburn, or dyspepsia for a week before they were enrolled in the study. Any change of dietary habits was not allowed. Subject exclusion criteria included a history of duodenal or gastric ulcer, dysphagia, gastrointestinal bleeding, coronary disease, anorexia, irritable bowel syndrome, other intestinal diseases, anemia, persistent vomiting. A written consent was done by all the study subjects.

Patients were followed up for 1 week before the study began; patients were each given about 500 ml of juice in a pasteurized glass bottle to be kept in the refrigerator for use. Plastic cups with 100 ml mark were distributed to all subjects. They were asked to drink about 100 ml of juice two times per day and whenever dyspeptic symptoms appeared for two weeks.

At the study end, each subject was asked to fill a form where two different scoring profiles were evaluated, first (GIS) gastro-intestinal symptoms profile. Gastroenterologists identified symptoms that were considered by patients as relevant. These symptoms were listed and symptoms identified and a 10 items profile for GIS were finally included (29). Each symptom with a score of 0 to 4. A higher value for worse symptoms while a lower value is given for mild symptoms. The GIS profile points are shown in table (1). The patients were helped by a trained physician to fill QOLRAD questionnaire form. QoLRAD, quality of life questionnaire for the gastroesophageal reflux disease, comprises 25 questions addressing concerns associated with gastrointestinal symptoms. The questions are rated with a 7-point Likert type scoring scale (1 = all the time; 7 = not at all). A high score indicates high quality of life, whereas a low score indicates low quality of life. The questions are categorized into five areas: Emotional Distress, Sleeping Disorders, Eating/Drinking Disorders, Physical/Social Function and Vitality. **Hançerlioğlu, et al.,** (30). Points form each profile were added then the mean ± SD of 12 patients was calculated, the two were also repeated at the end 1 week of the prepared juice intake to evaluate the juice effectiveness.

Table (1) GIS profile Points.

Nausea	an Urgent need of to vomit but it does not actually occur
Vomiting	unproductive retching or vomiting of mucus and gastric contents
Bloating	Feeling of congestion of food without relation to prior food intake
Abdominal cramps	Spasmodic or colic-like stomach pain without specified localization
Early satiety	Feeling that the stomach is overfilled soon after starting to rest, unproportional to the quantity of taken food, so that the meal cannot be finished

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Acid eructation / heartburn	Belching with acid taste, burning sensation in the esophagus
Sickness	Discomfort with the impression for the need to vomit
Loss of appetite	Listless for food intake
Retrosternal discomfort	Unpleasant feeling or pain behind the sternum
Epigastric or upper abdominal pain	localized pain below the sternum or in the upper abdomen

Adapted from **29 Adam et al., (2005)**. (18)

Juice organoleptic evaluation method:

Sweet potato juice product was sensory evaluated as described by **Hasani et al.,** (31), in this method, 12 trained panelists from the Food Science and Technology Department, NRC. They were asked to evaluate the juice with regard to the appearance / color, flavor, taste, consistency and overall perception using the following quality scales:

The scale for evaluation was 1= disliked extremely, 2 = disliked, 3 = neither liked nor disliked, 4 = good, 5 = excellent. The order of juice sample presentation was completely randomized for each of the panelists.

Statistical analysis:

Data were statistically analyzed by the pc program SPSS software, version 19 for Windows. Independent two-sample t-test was used to compare between mean values of the analyzed parameters. Data was represented as Mean ± SD. Values were considered significant at $p<0.05$, otherwise were considered non-significant.

3. Results and Discussions:

3.1. Effect of Pasteurization on the Bio-Active Constituents (vitamin C, antioxidant activity, Carotenoids, chlorophylls and total phenol compounds) in Batata juice:

The contents of the main bioactive compounds including vitamin C (ascorbic acid), chlorophylls, carotenoids, total phenols and antioxidant in sweet potato (Batata) juices were measured to examine the effects of pasteurization. The ascorbic acid content of fresh Batata juice was 0.320 mg/100ml after manufacturing, which was 0.192 reduced in the sample pasteurized (Table 2). However, the content of ascorbic acid was reduced significantly when pasteurization was applied. Fresh Batata juice originally had higher content of ascorbic acid, but pasteurization decreased the content of ascorbic acid to 60% of the original amount in fresh Batata juice (Table 2) which also leaded to more loss of vitamin C.

On the other hand, effect of pasteurization treatment on the content of total phenols of fresh and pasteurized Batata juice, expressed as µg equivalents of gallic acid (table 2). The data indicated that total phenols contents decreased due to pasteurization from 80.04 µg/100ml in fresh Batata juice to 72.04 µg/100ml in pasteurized-Batata juice. However, pasteurization treatment leaded to more loss of total phenol content in Batata juice.

The effect of pasteurization treatment on the antioxidant activity in fresh and pasteurized Batata juice was determined by DPPH radical scavenging activity expressed as percentage inhibition percentage (%), as seen in table (2).

The perusal of the data revealed that antioxidant activity increase in pasteurized Batata juice compared with fresh or unpasteurized Batata juice. For DPPH radical of antioxidant activity assay, which is based on the transfer of electrons from a donor molecule to the corresponding radical, enhancement in Inhibition % (87.5%) in pasteurized-Batata juice was due to pasteurization treatment compared with (88.5%) in fresh Batata juice. The reduction in the

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inhibition of DPPH was due to decreased total phenol content with the pasteurization treatment of Batata juice.

Total chlorophyll (Chl.A and Chl.B) and total carotenoids were decreased in pasteurized Batata juice compared with fresh Batata juice (Table 2). Chlorophyll A, Chlorophyll B and total chlorophyll (Chl.A and Chl.B) for pasteurized –Batata juice was 0.341, 0.740 and 1.080 mg/L, while total carotenoid was 0.326 mg/L respectively for the same sample. However, the results indicated that the Chlorophyll A, Chlorophyll B, total chlorophyll (Chl.A and Chl.B) and total carotenoids was increased in fresh Batata juice (0.461, 0.974, 1.435 and 0.367 mg/L), respectively. Whereas, the yellow color is due to the content of carotenoids in sweet potato (Batata) juice.

Many studies observed that sweet potato (Batata) juice were a good source of the Bio-Active constituents like vitamin C, carotenoids, antioxidants and total phenol compounds. However, Batata juices can be used as a food supplement for antioxidant compounds as polyphenols and carotenoids (22, 23, 24, 32, 33, 34).

Table (2): Effect of Pasteurization on the Bio-Active Constituents (vitamin C, antioxidant activity, Carotenoids, chlorophylls and total phenol compounds) in Batata juice.

Pre-treatments	Batata juice - Control	Pasteurized Batata juice 85^{o}C - 25min
Vitamin C (mg/100ml)	0.320	0.192
Chlorohyl A (mg/L)	0.461	0.341
Chlorohyl B (mg/L)	0.974	0.740
T. chlorophyls AB (mg/L)	1.435	1.080
T. carotenoids (mg/L)	0.367	0.326
Antioxidant-DPPH (%)	88.50%	87.50%
Total Phenols (µg/100ml)	80.0421	72.0423

3.2. Sensory evaluation:

The sensory properties (color, flavor, taste, consistency and overall quality) of the pasteurized sweet potato (Batata) juice (85^{o}C for 25min) were (3.6 ± 1.0, 3.8 ± 0.9, 3.4 ± 1.0, 2.5 ± 0.8 and 4 ± 0.8) respectively. Mean acceptance of sensory attributes of the juice sample shows that it is well accepted, as shown in table (3).

Table (3): Sensory evaluation properties of pasteurized (85^{o}C for 25min) sweet potato (Batata) juice product. **Score n=12 (Mean± SD)**

Sensory properties	Pasteurized Batata juice 85^{o}C - 25min
Color	3.6 ± 1.0
Flavor	3.8 ± 0.9
Taste	3.4 ± 1.0

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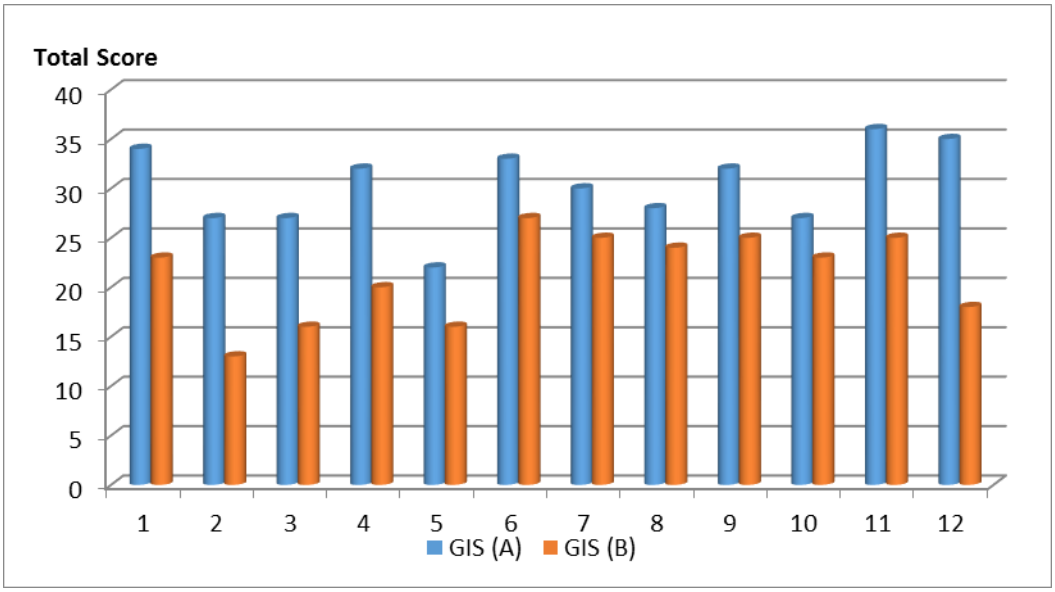
Consistency	2.5 ± 0.8
Overall quality	4 ± 0.8
Total	17.3 ± 4.5

3.3. GIS and QOLRAD scores before and after 2 weeks of potato (Batata) juice therapy:
The GIS profile showed a high significant improvement in symptoms especially for nausea (3.2 ± 0.09) to (2.3 ± 0.87), abdominal cramps (2.9 ± 08) to (2.3 ± 0.7), heart burn (2.9 ± 0.78) to (1.5 ± 1.0) and retrosternal discomfort (2.8± 0.6) to (2.5 ± 0.6). Episodes of sickness, vomiting, bloating, epigastric pain, loss of appetite and early satiety were also significantly improved Figure (2).

Figure (2) GIS values for each of the patients.



GIS (A) = before juice intake, GIS (B) = after juice intake. The greater the score the worse the symptoms, while a lower score points to a milder symptoms.

The mean of GIS score for each symptom is shown in figure (3), the SPJ is shown to improve each of these symptoms. Complementary to the GIS results, the QOLRAD scores shown in figure (4) also improved after two weeks of drinking the SPJ. However, the differences in baseline QOLRAD in the profile score of emotional upset, sleep disturbance, eating / drinking problems, social / physical activity and feeling of vitality between base line and after two weeks of SPJ intake were clinically significant ($P \leq 0.005$) figure (4).
Figure (3) Mean GIS assessment scores for each patient before and after sweet potato juice intake.

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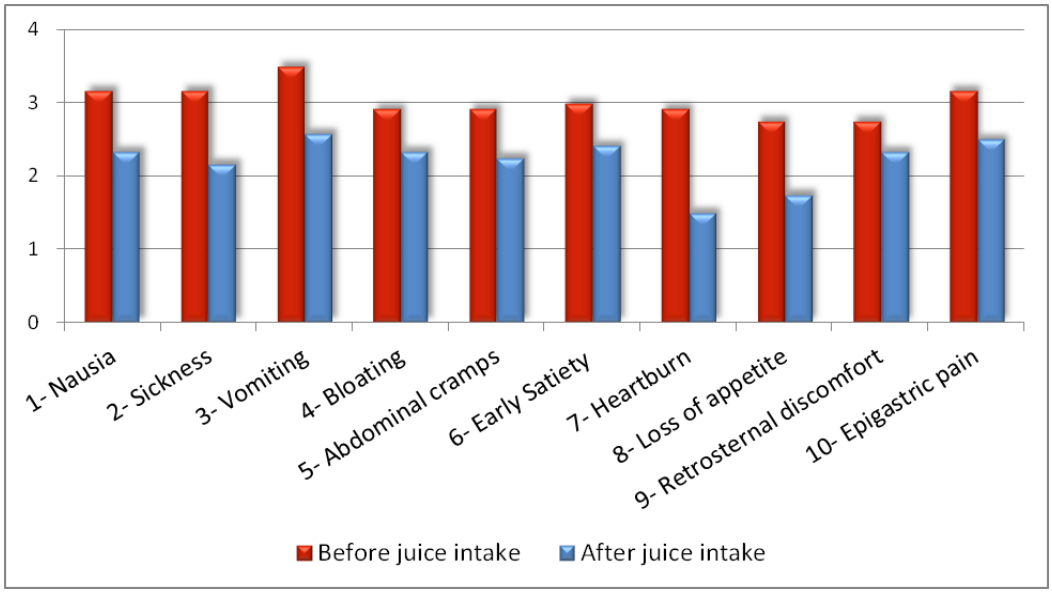
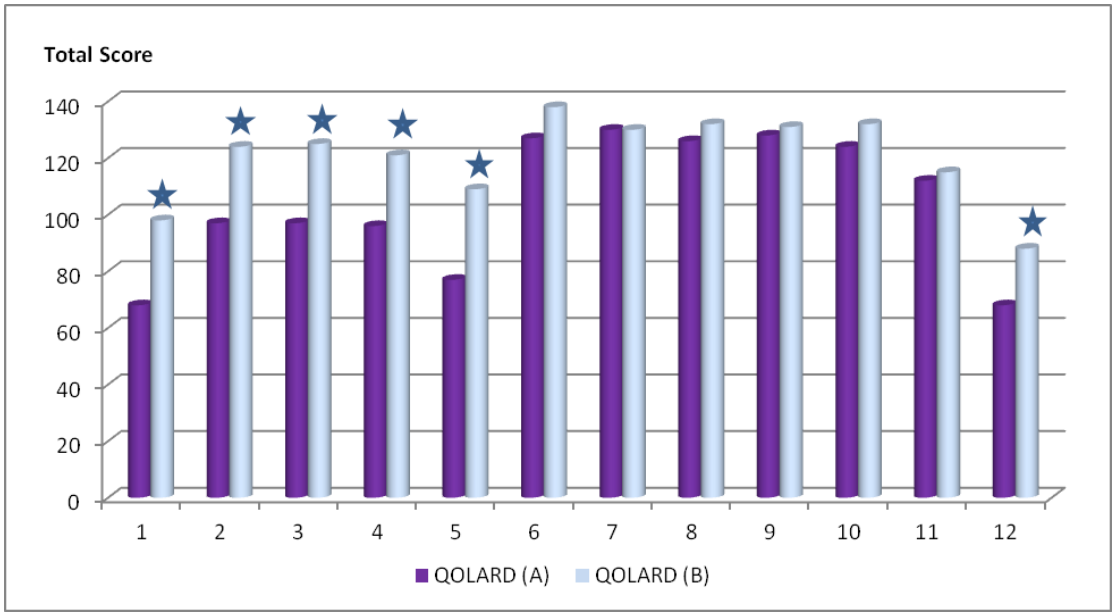


Figure (4) QOLARD scores for each of the patients.



*QOLARD mean score for each of the patients. A= before juice intake (baseline), QOLARD B= after juice intake. Higher scores indicate a better quality of life. * Significant P < 0.005 vs baseline*

Several phytochemical studies on Sweet potatoes have detected numerous potential compounds with profound medicinal benefits such as pantothenic acid (vitamin B5) and pyridoxine (vitamin B6) (35), β-carotene, iron, calcium, protein (36), polyphenols (37).
On preliminary phyto-chemical screening, the tuber extract revealed the presence of phenolic compounds, polysaccharides, saponin glycosides and flavonoids as major compounds that might have contributed to its antioxidant activity (38).
Thus, the increase in acid secretion is a consequence of acetylcholine action on the histamine cell and parietal cell activity. Stress-induced ulcers also involve damage by reactive oxygen species (ROS) apart from acid and pepsin related factors (39). The anti-ulcerative effect of SPJ against cold stress induced ulcer in rats appears to be related to the inhibition of lipid peroxidative processes and to the prevention of GSH depletion. Furthermore, it may be stated

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that SPJ exerts its antioxidant activity by a dual action – by enzymatic as well as non-enzymatic pathways (40).

In summary, the observed effect of SPJ on upper GI complaints can probably be attributed to its naturally high content of polyphenols. Also the antioxidant potential of the SPJ, is thought to prevent heartburn by therapeutic potential as anti-inflammatory agent (40).

This finding is thought to be due to a reduction in the level of pro-inflammatory cytokines, TNF-α, attributed to the synergy of bioactive compounds as well as to the specific interactions with other nutrients (41), as there are many compounds present in the tested preparation of the sweet potato juice, such as phenolic acids, and proteins, which have been suggested to contribute to gastrointestinal protection (42). Further work on their biological activities could improve our knowledge about the mechanisms underlying the beneficial effects noted in the current experiment.

It should be mentioned that there are some limitations of this study. The present study was designed without a control group as an explorative pilot study, as clinical data on the efficacy of drinking sweet potato juice on heartburn and dyspepsia was not available. Although the outcome of the pre-post study design allows for the assumption that the SPJ reduces heartburn and dyspeptic symptoms, a large-scale, randomized, placebo controlled clinical trial is necessary to confirm the outcomes of the present study.

In this study patients were selected on the basis of self-reporting of heartburn. In future studies, standardized diagnostic criteria such as e.g. ROME III criteria, endoscopy, etc. should be used as proper inclusion criteria.

The study shows that the daily consumption of the SPJ is a good source of the Bio-active constituents like vitamin C, carotenoids, antioxidants and total phenol compounds that might have ameliorated the gastrointestinal complaints of dyspepsia. It also provides the first clinical evidence of the beneficial effect of drinking 100 ml twice/day of SPJ on dyspeptic symptoms and heartburn. Given the fact that functional dyspepsia and heartburn impact work, productivity and lead to substantial healthcare costs (43). The SPJ was demonstrated to be safe and tolerable alternative remedy helping to reduce direct and indirect treatment costs of heartburn and functional dyspepsia.

Although there is a demand for further randomized, placebo-controlled trials, drinking the SPJ is recommended for patients with stomach upset and heartburn to help reduce accompanying symptoms and thereby improve quality of animation.

Conclusion:

Previous results concluded that the use of the thermal method and pasteurization led to an increase in the distinctive taste production of delicious sweet potato (Batata) juice. The results also showed that pasteurized sweet potato (Batata) juice was rich in vitamin C content, totoal phenolic compounds, antioxidant activity and total carotenoids compounds with good sensory properties of Batata juice. The present study shows that the tubers of Ipomoea Batatas possess a potent ulcer healing effect, which seems to be connected to the free radical scavenging activity of the Phyto-constituents, and their ability to inhibit lipid peroxidative processes. It also aims to highlight the health benefits of sweet potato juice, establish it as a potent “functional food” for the management of dyspepsia.

Conflict of interest:

The authors declare that there is no competing interest exists.

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