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ASSESSMENT OF ANTIOXIDANT AND ANTI-MALARIAL COMPONENTS IN FRUIT SEEDS USING UV-VISIBLE SPECTROSCOPY

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Abstract

This study evaluates the anti-oxidant as well as anti-malarial effects of bioactive constituents determined in various fruit seeds, particularly caper berry, garlic, almond, walnut, melon and watermelon collected from Taluka Faiz Ganj, District Khairpur Mir's, Sindh, Pakistan. Fruit seeds, which contain useful phytochemicals that could be used in the coordination of the circular economy, are typically discarded as agricultural waste. UV-visible spectroscopy was used to measure four main parameters: rutin, gallic acid, artemether, and quercetin. The maximum concentrations of all the chemicals under study were observed in walnut seeds including Rutin (20.20 mg/g), Gallic acid (2.06 mg/g), Artemether (3.09 mg/g), and Quercetin (20.61 mg/g). Melon as well as watermelon seeds also declared to be useful contributors of these bioactive components, with almonds possessing the minimum amounts. These results provide scientific support to the conventional therapeutic practice of these seeds and specify hopeful opportunities for changing agricultural byproducts into efficient food constituents, nutraceuticals, and medicines to address chronic illnesses and oxidative stress.

Keywords: *Fruit Seeds, Phytochemicals, UV-Visible Spectroscopy, Anti-malarial, Artemether, Quercetin, Taluka Faiz Ganj.*

INTRODUCTION

The global agricultural and food processing segments create a large amount of fruit byproducts, for instance peels, pulp, and seeds, which are often discarded as waste [1]. These substances not only cause an ecological hazard due to dumping concerns, but also result in a large loss of potentially affluent bioactive possessions. Recently, there has been a flow in scientific as well as commercial interest in using these offshoots by extracting and characterizing their phytochemical components for use in useful food, nutraceuticals and medications [2]. The fruits and seeds, mostly, have exposed guarantee as source of nutritionally valuable material and therapeutic phytochemicals [3]. Seeds from different varieties, which are often unnecessary after fruit processing, comprise high levels of lipids, minerals, dietary fibers, and proteins as well as a broad range of phenolic compounds, carotenoids, tocopherols, and phytosterols [4,5]. The Cucurbitaceae family, which comprises melons as well as watermelons, offers seeds with very inspiring dietary character. On the basis of dry weight, melon seeds (Cucumis melo L.) consist of about 25.32% dietary fiber, 27.41% protein, and30.65% oil as well as noteworthy content of antioxidant phenols [5,6]. In the same way, watermelon seeds have been found to contain as high level of lipids, vitamins, minerals, and proteins, all of which have been related to better health [8].

Bioactive compounds viz phytochemicals are observed naturally in plants that provide significant functions in human health prior to eating [9]. These chemicals display a broad range of biological proceedings containing antioxidant, anti-inflammatory, anti-proliferative, antiviral, and hypocholesterolemic properties. The medicinal potential of phytochemicals is chiefly essential in the situation of persistent non-communicable diseases, which account for about 74% of all global fatalities every year, frequently from diabetes, chronic respiratory disease, cancer, and cardiovascular disease [10, 11].

This work looks at the remedial potential of underutilized fruit seeds, mostly caper berry, garlic, almond, melon, walnut, and watermelon collected from Taluka Faiz Ganj, District Khairpur Mir's as natural agents against oxidative stress and chronic inflammation [12]. The objective of the study is to characterize an extensive range of bioactive components via UV-Visible Spectroscopy a well as standardized tests, including anti-malarial such as Artemether, and strong antioxidants like Rutin, Gallic acid, Quercetin and organosulfur compounds such as allicin [13]. These phytochemicals have a number of health advantages, including cardiovascular protection, blood

pressure reduction, and antibacterial and anticancer properties [14]. The present work shows systematic validation for conventional therapeutic uses by scientifically quantifying these compounds and assessing their synergistic biological efficiency, as well as discovering high value pathways for transforming agricultural byproducts into useful food components and nutraceuticals. The study demonstrates how frequently thrown seeds can be transformed from environmental liabilities to financial potential through value-added applications by addressing agricultural waste valorization within a global wealth structure.

These exposed phytochemical reports have important public health suggestions for avoiding unending diseases originated by oxidative stress and irritation, as well as might guide local dietary recommendations and the public health programs [15]. Efficiently, the work offers a pathway for rural diversification by producing new income flow throughout the creation of nutraceutical and decorative precursors resulting from underused substances. Moreover, the grouping of predictable selection and complicated diagnostic procedures generates a powerful practical basis for quality control and commercialization. Eventually, this broad agenda brings collectively conventional farming background and current research to confirm confined resources and alter them into globally applicable health – promoting goods.

Study Area

Taluka Faiz Ganj belongs to District Khairpur Mir's and is its administrative unit, having its headquarters at Pacca Chang located on Mehran Highway. The taluka is located in the south of the district having its borders with Shaheed Benazir Abad and Naushahro Feroz and is organized into various Union Councils and town committees including Karoondi on administration basis. The population of the region is about 146,436 people; most of them speak Sindhi and live in rural rears. The ecosystem is differentiated by significant temperature variations, ranging from near – freezing winters to warm summers exceeding 50 ºC, which supports the farming of distinctive local crops like dates. This affluent topography supports an extensive range of agricultural outputs, consisting Rabi crops such as wheat and gramme, Kharif crops such as rice and cotton, as well as considerable crop of melons and watermelons. Apart from its agricultural profits, the area is also an important donor to the nation's natural gas resources, relating routine farming with critical manufacturing production [16].

Figure: 1 Map of Taluka Faiz Ganj

MATERIAL AND METHODS

Sample Collection

Fresh seed varieties for instance caper berry, watermelon, melon, almond, walnut, and garlic were received directly from farming land in Taluka Faiz Ganj, District Khairpur Mir's. Some varieties which were not grown locally were bought from commercial marketplaces in Khairpur Mir's. All collected seeds were sealed in polyethylene bags and transported to the Institute of Chemistry Shah Abdul Latif University Khairpur Mir's for thorough physical as well as chemical examination [17].

Sample Preparation

For extraction procedure, a reflux setup containing a round bottomed flask and condenser was used, and temperature maintained at 65 – 75 ºC on magnetic hot plate. A magnetic stirrer was utilized in the flask to support in the efficient recovery of chemicals from the solvent. For sample preparation 100 g of each variety was taken and finely divided, then 1 g of each grounded sample was measured and dissolved in 10 m L ethanol for extraction purpose. Consequently, the

resultant solutions were filtered with Whatmann # 42 filter paper to ensure purity before being measured using UV-Visible Spectrophotometer [18].

Sample Analysis

Seed samples were prepared for the determination of Artemether, Rutin, Gallic acid, and Quercetin. The collected samples were completely cleansed and dried before macerated. These macerated samples were then extracted with methanol with the help of reflux equipment containing round bottomed flask, condenser and magnetic stirrer on hot plate for as a minimum 15 minutes. Subsequent to the extraction, the samples were filtered; the liquid was placed in bottles. Eventually, concentrations were determined by calibration graphs and taking absorbance readings with the help of double beam UV-Visible Spectrophotometer over the wavelength range of 250 – 700 nm [19].

Preparation of Stock Standard Solutions

A chemical balance was used to accurately weigh the amounts of pure Artemether, Rutin, Gallic acid, and Quercetin in order to prepare the stock standard solutions for the under studied parameters. To approach the initial concentration 0f 1000 mg/L, each component was dissolved in a particular quantity of high purity methanol. To avoid degradation of phytochemicals and maintain chemical stability, these solutions were mixed thoroughly using magnetic stirrer before placing in amber – colored glass bottles at lower temperatures. a set of working standards was created by serial dilution from these concentrated stock solutions, which were then used to generate calibration graphs with the help of double – beam UV-Visible Spectrophotometer.

RESULTS AND DISCUSSION

Rutin

Rutin is a flavonoid glycoside recognized for its significant role in cardiovascular health, remarkably in reducing capillary weakness and treating hypertension [20]. In the present work, walnuts were found to contain the highest content of Rutin (20.20 mg/g), followed closely by melon and watermelon. The concentration order of Rutin was found as; Walnut >Melon > Watermelon > Cappers > Garlic > Almond. The availability of such high quantities, especially in

walnut and melon describes that these seeds are effective natural source of antioxidant protection and blood vessel strengthening.

Gallic Acid

Gallic acid is a hydrolysable tannin monomer recognized for its hepatoprotective (liver-protective) and antiviral consequences [21]. The quantitative analysis exposed that walnut seeds possess the maximum level of 2.06 mg/g of Gallic acid, whereas almonds have the minimum content of 0.62 mg/g. The order of concentration of Gallic acid was found as Walnut > Watermelon > Melon > Cappers > Garlic > Almond. These results propose that walnut and watermelon seeds from district Khairpur possess a higher content of this phenolic acid as compared to other local varieties.

Artemether

Artemether is a significant anti-malarial alkaloid derivative that, when mixed with haemin, disturbs the life cycle of malarial parasites [22]. The results show that walnut seeds were found to contain the maximum content of 3.09 mg/g of Artemether, whereas the minimum content of 1.17 mg/g was observed in almonds. Walnut > Melon > Watermelon > Cappers > Garlic > Almond was the observed concentration order of Artemether. The significant levels of Artemether found in watermelon and melon indicate that these agricultural byproducts may be additional sources of anti-malarial compounds.

Quercetin

The anti-inflammatory, potent antioxidant and health-promoting qualities of quercetin a well-known bioflavonoid with a hexagonal phenolic formation have been extensively studied [23]. Walnut seeds had the highest amount of quercetin (20.61 mg/g) compared to other standards, while almonds had the lowest amount (6.15 mg/g). Walnut > Melon > Watermelon > Cappers > Garlic > Almond was found to be the order of flavonoid concentration. According to these findings, walnut and melon seeds from the study area are excellent sources of quercetin and have a lot of potential for use in the pharmaceutical and nutraceutical industries.

Table: 1 Comparative quantitative analysis of bioactive phytochemicals (quercetin, rutin, gallic acid, and artemether) in various fruit seed varieties

Fruit Seed	Rutin (mg/g)	Gallic Acid (mg/g)	Artemether (mg/g)	Quercetin (mg/g)
Walnut	20.20	2.06	3.09	20.61
Melon	18.79	1.82	2.95	18.23
Watermelon	17.51	1.64	2.53	16.36
Cappers	15.83	1.34	2.48	13.40
Garlic	8.48	0.78	1.57	7.85
Almonds	5.34	0.62	1.17	6.15

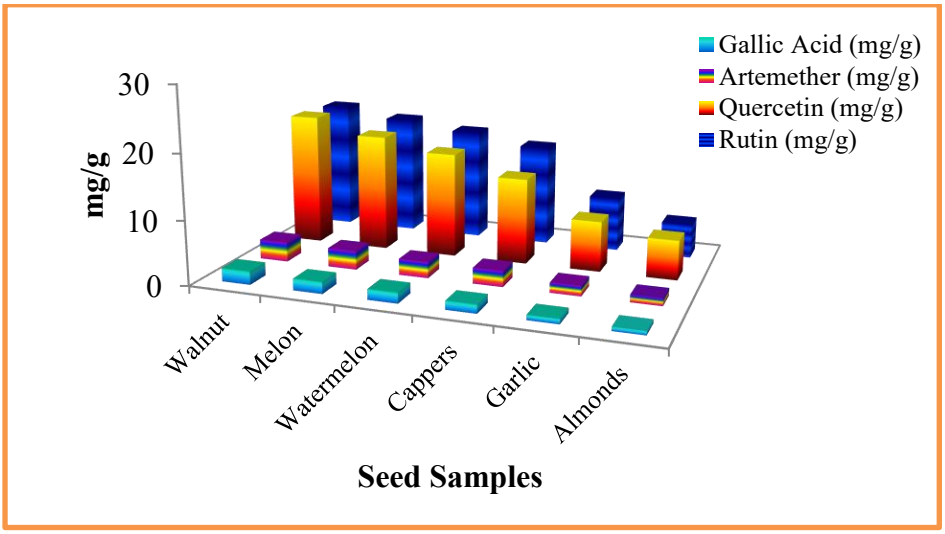


Figure: 2 Relative contents of Phytochemicals (mg/g) in Selected Fruit Seed Samples

The distribution of the four main bioactive parameters—quercetin, rutin, gallic acid, and artemether—among the six types of seeds examined (walnut, melons, watermelons, cappers, garlic, and almonds) is shown in the graph. The data shows a similar pattern: Walnuts have the highest concentrations of all the chemicals found, while almonds frequently have the lowest concentrations (Figure: 2).

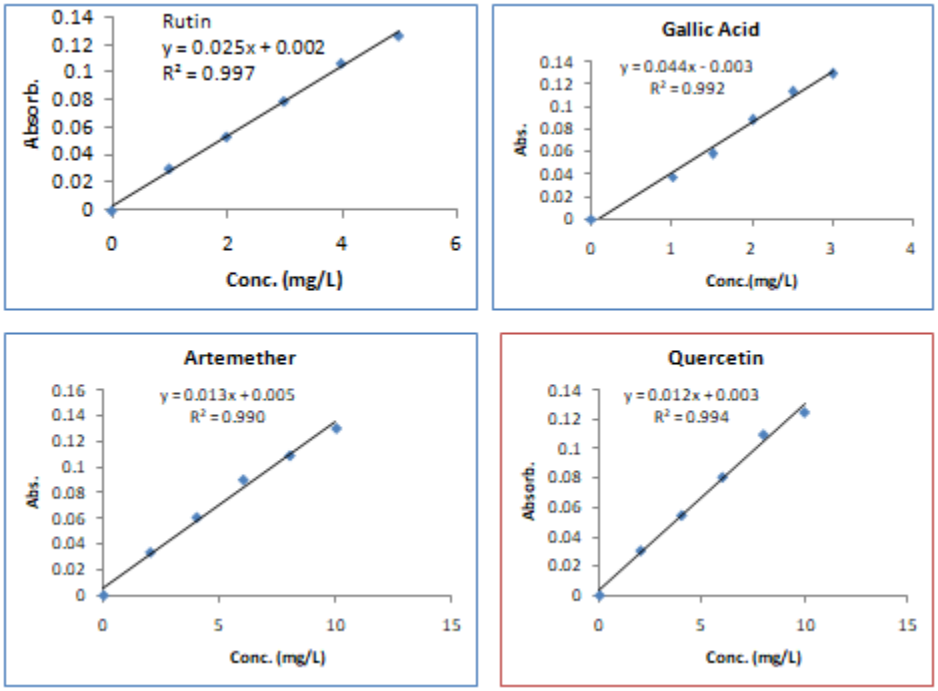
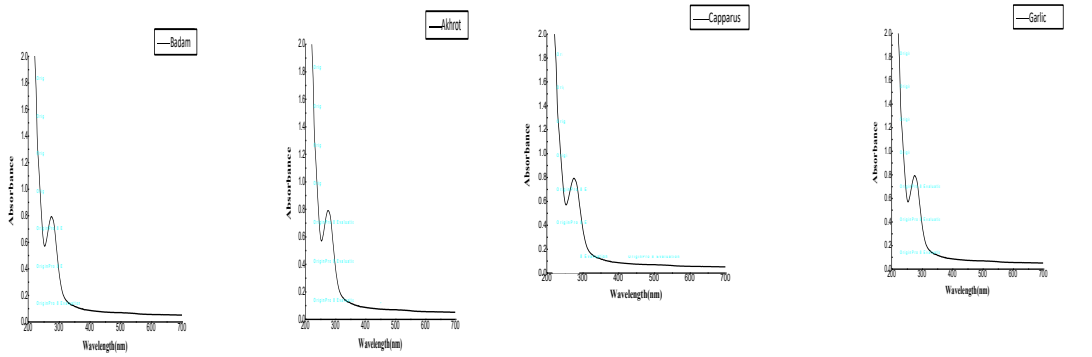
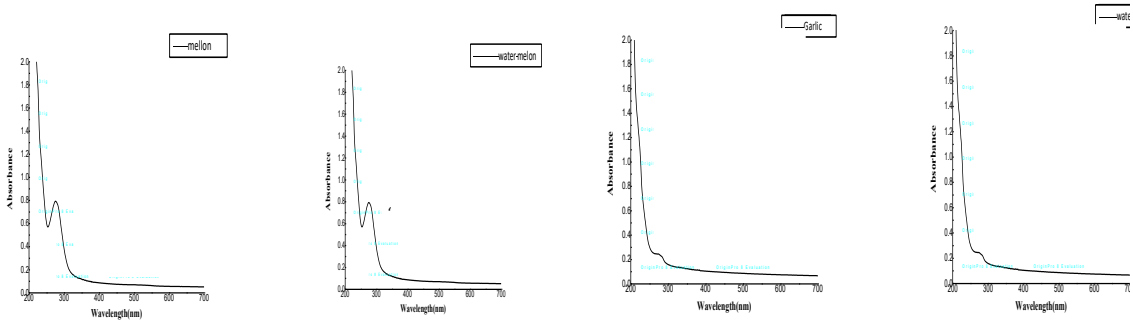


Figure 3 The calibration graphs for Rutin, Gallic Acid, Artemether, and Quercetin.



(a) (b)



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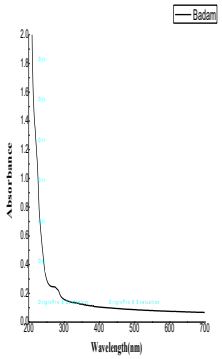
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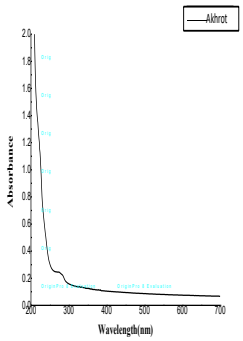
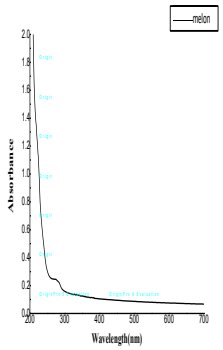
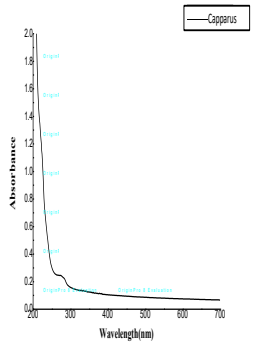
Absorbance
Wavelength(nm)

(d)


Akhrot
Absorbance
Wavelength(nm)


melon
Absorbance
Wavelength(nm)


Capparus
Absorbance
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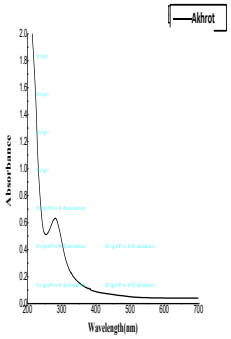
(e)

(f)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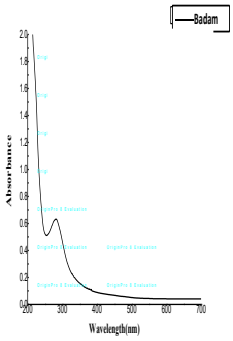
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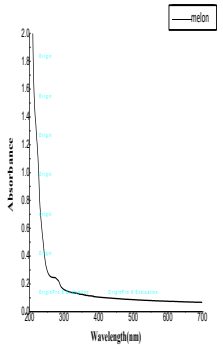
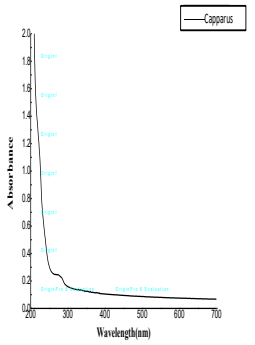
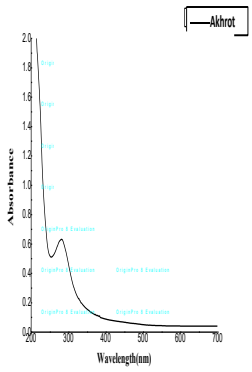

melon
Absorbance
Wavelength(nm)


Capparus
Absorbance
Wavelength(nm)

(g)

(h)


Akhrot
Absorbance
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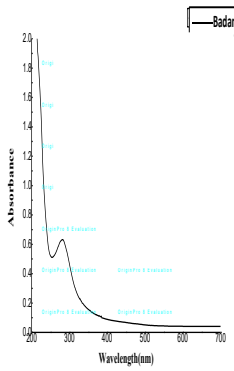
Badam
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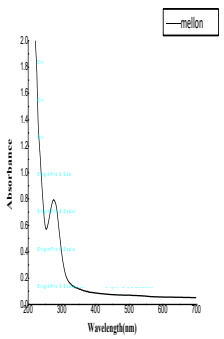
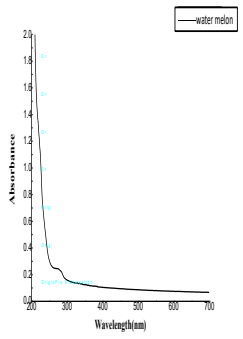
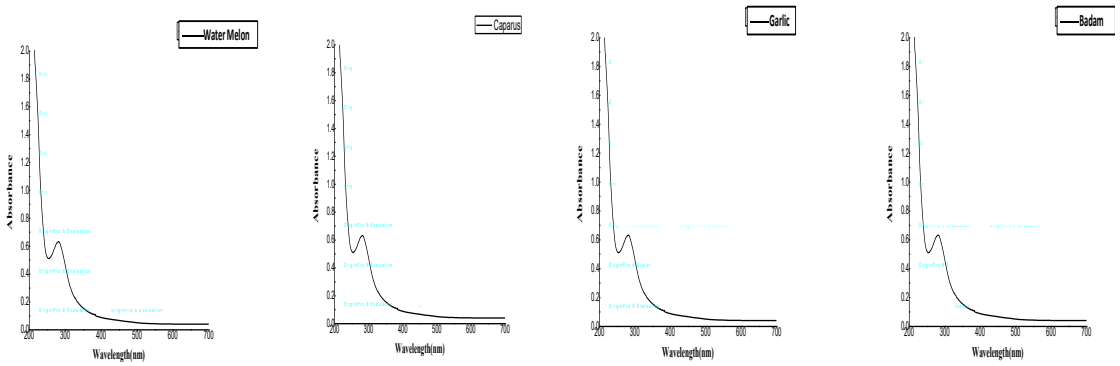

melon
Absorbance
Wavelength(nm)


water melon
Absorbance
Wavelength(nm)

(i)

(j)



(k) (l)

Figure: 4 Spectra of (a) Rutin in almond and walnut (b) Rutin in Cappers and Garlic (c) Rutin in melon and water melon (d) Gallic acid in almond and walnut (e) Gallic acid in garlic and watermelon (f) Gallic acid in melon and cappers (g) Quercetin in walnut and almond (h) quercetin in garlic and melon (i) Quercetin in watermelon and cappers (j) artemether in walnut and Capers (k) artemether in melon and watermelon (l) Artemether in garlic and almonds

CONCLUSION

The study was effective in identifying the phytochemical profiles of six regional seed types, revealing their significant medicinal potential. The quantitative study revealed a clear content climb for the bioactive chemicals: walnuts > melon > watermelon > capers > garlic > almonds. In terms of antioxidant potential, walnut and melon seeds contain considerable amounts of Rutin and Quercetin, indicating that they are great sources of cardiovascular protection and anti-inflammatory properties. In terms of anti-malarial potential, the level of Artemether in watermelon and melon seeds surpasses 2.5 mg/g, indicating that these agricultural byproducts are promising sources of anti-malarial therapy. Moreover, the finding of Gallic acid, particularly in walnut and watermelon, provides support to their use as liver-protective (hepatoprotective) and antiviral medicines. Finally, this study relates ancient agricultural approaches to contemporary analytical science. The study serves a dual purpose by identifying these seeds as rich sources of bioactive compounds rather than simply waste, reducing the environmental impact of agricultural disposal while also creating new economic opportunities for rural communities through the production of nutraceutical and cosmetic precursors.

Author Contribution

Aijaz Ali Shar conceptualized, collected samples, designed experiments, Ammat - ur - Rehman Soomro and Dr. Abdul Raheem Shar prepared the draft of the article, Rabia Parveen Memon and Hajra Kharal interpreted the data, Sahib Ghanghro and Seema Sarwar Ghumro performed experimental analysis, Prof. Dr. Ghulam Qadir Shar supervised the whole work, all authors read, revised, and approved the final version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest

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