21. A Review on Study of some Phytochemicals in the Aqueous Extract of the Endocarp, Seeds and Exocarp of Watermelon *(Citrullus Lanatus)* Fruit

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Watermelon (*Citrullus lanatus*) is a fruit vegetable, belongs to the genus *Citrullus* and the family Cucurbitaceae. Watermelon biomass can be categorized into three main components, which are flesh, seed, and rind. Flesh contributes to approximately 40% of the total weight, the rind and seeds represent approximately 60% of total watermelon fruit.. This study was aimed at comparatively evaluating phytochmicals in the endocarp, seeds and exocarp of this fruit. Phytochemical tests revealed that, terpenoids, flavonoids and saponins were significantly (p<0.05) higher in the endocarp, whereas, alkaloids, total phenols, cyanogenic glycosides and anthraquinones were significantly (p<0.05) higher in the exocarp. The entire fruit may be consumed since every part had phytochemicals of medicinal relevance; instead of the common practice of discarding the exocarp and seeds.

Keywords: *Citrullus lanatus*, phytoconstituents, exocarp, indigenous.

Introduction

The Watermelon plant with scientific name *Citrullus lanatus* belongs to the Cucurbitaceae family. It is a large, sprawling annual plant with coarse, hairy, pinnately-lobed (3 to 7 lobes) dark green, long-stalked, oblong-ovate leaves (8 to 20cm) with prominent veins and white to yellow monoecious flowers (about 2 cm in diameter) occurring singly in axils [1, 2]. It is grown for its edible fruit, also known as watermelon, which is a special kind of berry botanically known as pepo. The fruit is very large and ellipsoid to oblong with light or deep green or yellow coloured, smooth thick exterior exocarp with irregular grey or light green vertical stripes, sometimes covered with a white waxy bloom, about 30 cm. long. The fleshy endocarp is either white, pink, red or even yellow and usually crispy, soft and juicy with many compressed seeds which can be black, brown, white, green, or yellow embedded in the middle third layer; some are however seedless [3, 4, 2]. Watermelon constitutes approximately 68 % flesh, the rind 30% and the seed 2% of the total fruit weight Generally, watermelon endocarp is the main consumable portion; however, the outer exocarp or rind is also used in some parts of the world [5, 6].

Watermelon is generally used as thirst quencher and in the very dry areas and desert of Africa;it is usually relished by both humans and animals as a source of water. The fruits are generally eaten raw and the seeds are sometimes grounded to form flour. The young leaves are also cooked or added to soup. Watermelon seed oil is edible oil quite similar to sunflower oil [7].*Citrullus lanatus* (watermelon) with the red fleshy endocarp is a rich source of phytochemicals especially lycopene, vitamin C as well as the amino-acid citrulline.. However, watermelon extract is recommended to formulate cosmetic products at protecting the hair integrity and skin against oxidative process [32]. The useful process of these natural phytochemicals are terpenoids, carotenoids, flavonoids, steroids, alkaloids, tannins and glycosides are antibiotic principles of plants [31]on (*Citrullus lanatus*) Pulp, Peels and Seeds [33]. They are usually distributed in plants. These phytochemicals have been reported to exhibit foaming activity, antifungal property, hemolytic and anti-inflammatory [31]. Although roots, flowers, leaf and whole plants, and stems were examined for useful phytochemicals in many research projects, few reports referred to seeds as sources for pharmaceuticals [34]. The purpose of this research work was to determine the phytochemical analyses of watermelon peels, pulp and seeds respectively.

Materials and Methods

Reagents/chemicals

All reagents and chemicals used were of analytical grade and products of Laboratory.

Collection and identification of the watermelon fruit

The watermelon whole fruit was collected. The ripe one was confirmed by a hollow sound when hit with the palm. Field identification of the sample was carried out by a Botanist and identified as *Citrullus lanatus* (watermelon).

Preliminary treatment and extraction procedure of the watermelon fruit

The watermelon fruit was washed thoroughly with tap water and cut into pieces to obtain the various samples i.e. endocarp, seeds and exocarp (rind + the white part) for analysis. The seeds were washed again separately to remove all traces of the endocarp. All the fresh samples were separately ground with distilled water into a viscous liquid using an electric blender. Thereafter filtration was carried out using porcelain and eventually clearer filtrates were obtained using Whatman's No.1 filter paper. This served as the aqueous extracts that were evaluated for varied phytoconstituents.

Phytochemical analysis of the endocarp, seeds and exocarp of the watermelon fruit

Qualitative phytochemical tests were carried out on the aqueous extracts of the endocarp, seeds and exocarp using standard conventional procedures to identify the phytochemicals as described by [13-17].

Quantitative phytochemical analyses were carried out as follows:

1. Total phenolics was determined using Folin-Ciocalteau reagent (FCR) with slight modifications [18].
2. Tannin content in each sample was determined using insoluble polyvinyl-polypirrolidone (PVPP), which binds tannins [19].
4. Flavonoid content was estimated according to a slightly modified method [20].
5. Estimation of alkaloid and saponins contents [21].
6. Estimation of anthraquinone and cardiac glycoside contents [15].
7. Estimation cyanogenic glycoside content [22].

Statistical Analysis

The data collected from this study were subjected to statistical analysis using SPSS version 22 (IBM, 2014) and the results expressed as mean ± SEM. One way analysis of variance (ANOVA) was also used to compare the means of all the parameters measured and where significant differences were observed at 95% confidence level i.e. $p<0.05$, Duncan's New multiple Range test was used to identify them.

Results

Qualitative phytochemical content in the aqueous extract of the watermelon fruit endocarp, seed and exocarp

The qualitative phytochemical composition of the watermelon fruit summarised in Table 1. It was observed that in all parts of the fruit used there were no steroids, tannins However in the endocarp of the fruit there were high levels of terpenoids, saponins and carotenoids but alkaloids and cyanogenic glycosides were absent. The exocarp on the other hand indicated relatively high levels of alkaloids and cardiac glycosides. Whereas moderate amounts of terpenoids, alkaloids, cardiac glycosides and cyanogenic glycosides were observed in seed.

Table 1: Qualitative phytochemical content in the aqueous extract of the watermelon fruit endocarp, seed and exocarp

Parameter	Endocarp	Seed	Exocarp
Steroids	-	-	-
Terpenoids	+++	++	+
Alkaloids	-	++	+++
Saponins	+++	+	++
Tannins	-	-	-
Carotenoids	+++	+	++
Anthraquinones	++	-	+
Phlobatannins	+	-	-
Cardiac glycosides	+	++	+++
Cyanogenic glycosides	-	++	+

Key: + Low; ++ Moderate; +++ High; - not detected

Quantitative phytochemical content in the aqueous extract of the watermelon fruit endocarp, seed and exocarp

The quantitative phytochemical composition of the endocarp, seed and exocarp of the watermelon fruit evaluated are summarised in Table 2. It was generally observed that all the phytochemicals estimated were present in varied amounts in all the different parts of the fruit but tannins were visibly absent. Alkaloids, total phenols, cyanogenic glycosides and anthraquinones were significantly ($p<0.05$) higher in the Values represent mean ± SEM of triplicate determinations. Means of the same row followed by different lettered superscripts differ significantly ($p<0.05$).

Quantitative Determination (mg/100 g)	Endocarp	Seeds	Exocarps
Alkaloids	0.00 ± 0.00c	19.73 ± 0.23b	37.42 ± 0.35a
Total phenols	33.53 ± 1.07c	42.10 ± 0.50b	52.02 ± 0.79a
Saponins	25.55 ± 0.91a	0.08 ± 0.00c	17.79 ± 0.65b
Tannins	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Cardiac glycosides	0.00 ± 0.00a	2.92 ± 2.21a	1.61 ± 0.14a
Flavonoids	11.44 ± 0.80a	3.98 ± 0.05b	2.32 ± 0.31b
Terpenoids	7.48 ± 0.76a	3.78 ± 0.04b	1.56 ± 0.10c
Cyanogenic glycoside	3.95 ± 0.17c	7.63 ± 0.39b	9.49 ± 0.37a
Anthraquinones	0.18 ± 0.03b	0.00 ± 0.00c	5.61 ± 0.05a

Phlobatannins	1.38 ± 0.08a	1.46 ± 1.46a	0.00 ± 0.00a
Antioxidants	7.42 ± 0.50a	4.96 ± 0.29c	6.43 ± 0.35b

Table 2: Quantitative phytochemical content in the aqueous extract of the watermelon fruit endocarp, seed and exocarp

Discussion

Phytoconstituents in plant parts like leaves, fruits, seeds, flowers, roots, stem, and bark has attracted the attention of plant researchers due to their biological activities as well as efficacies relevant in the development of new and modern drugs for the pharmaceutical industry [26]. Many plant secondary metabolites are known to provide protection and treatment roles against various human disorders, including but not limited to microbial infections, cancer, diabetes, hypertension and Alzheimer's disease [27]. There are also phytochemicals with relevant physiological properties which may be elements/minerals rather than complex organic molecules.

The qualitative phytochemical analysis obtained in this study (Table 1) revealed that in all parts of the watermelon fruit used (endocarp, seed and exocarp) there were no steroids, tannins and anthocyanins. However in the endocarp, there were high levels of terpenoids, saponins and carotenoids but alkaloids and cyanogenic glycosides were absent. The exocarp on the other hand indicated relatively high levels of alkaloids and cardiac glycosides. Whereas moderate amounts of terpenoids, alkaloids, cardiac glycosides and cyanogenic glycosides were observed in the seed.

The quantitative phytochemical screening of the aqueous extracts of the endocarp, seed and exocarp of the watermelon fruit (Table 2) revealed that the concentration of alkaloids, total phenols, cyanogenic glycosides and anthraquinones were significantly higher in the exocarp relative to the fleshy endocarp and the seeds while saponins, flavonoids, antioxidants and terpenoids were significantly higher in the endocarp.

These results partially agrees with the report by previous authors [30], who established that the watermelon rind (exocarp) comparatively contained a higher concentration of alkaloids, and phenols compared to the seeds although the values obtained were obviously lower. Alkaloids are organic nitrogenous compounds, said to exhibit remarkable physiological activity in animals [31]. Isolated plant alkaloids and their synthetic derivatives are basic medicinal agents used as central nervous system stimulants, topical analgesics, ophthalmologic, antispasmodic and bactericidal effects [31]. The absence of tannins in this study may suggest that the samples lack astringent and antimicrobial properties [32], but it is worthy of note that other available phytochemicals might have these functions e.g. phenolic compounds function as antimicrobial compounds that can get rid of plant pathogens [31].

In this study, the flavonoid concentration in the endocarp was significantly higher when compared to the seed and exocarp and this agreed favourably with the report by a previous author [29]. However, the flavonoid level in the seed was significantly higher compared to the exocarp in this study, but the reverse was the case in the report of a by previous author [30]. Flavonoids are water-soluble plant phenolics that have been shown to have antibacterial, antifungal, antiinflammatory, antiallergic, antimutagenic, antiviral antineoplastic, antithrombotic and vasodilatory activity The potent antioxidant activity of flavonoids and their ability to scavenge hydroxyl radicals, superoxide anions and lipid peroxyl radicals may aid in related disorders [32]. Thus the availability of flavonoids in the samples suggests that they may offer protection against ailments related to free radical**s**, bacterial and fungal activities [32].There were no cardiac glycosides in the endocarp while the amount in the exocarp and seed were low .

Conclusion

Knowledge of the phytochemical, proximate and mineral composition in a food substance provides an idea of its pharmacologic, dietary and toxic potentials. It was on this premise that the quantitative analysis is on parts of the watermelon fruit (endocarp, seed and exocarp) was carried out and it revealed a comparatively, significant concentration of several important and powerful phytoconstituents. peels indicates the presence of alkaloids, saponins, carbohydrate, cardiac glycosides and terpenoids, while the pulp indicate the presence of saponins and seeds of watermelon revealed the presence of alkaloids, carbohydrate, steroids, and cardiac glycosides respectively. These results implies that the presence of these phytoconstituents of watermelon is highly medicinal and also serve as food (Sadiq et al., 2016). Watermelon peel, much like watermelon flesh, is mostly made of water because of the presence of phytoconstituents; saponins, steroids, tannins, terpenoids used as antibacterial and antifungal agent and boost the immune system.

Hence, this study concludes that it is beneficial to consume the watermelon fruit whole to derive relevant phytoconstituents from it.

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