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Serigne Ibra Mbacke DIENG
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

Amadou Jarouga DIALLO
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

Alioune Dior FALL
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

Kady DIATTA-BADJI
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

William DIATTA
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

Abdou SARR
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal.*

Emmanuel BASSENE
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-Fann, Sénégal*

Correspondence
Serigne Ibra Mbacke DIENG
Laboratory of Pharmacognosy and Botany, Cheikh Anta DIOP University, *B.P. 5005, Dakar-*

Total polyphenols and flavonoids contents of aqueous extracts of watermelon red flesh and peels (*Citrullus lanatus*, Thunb)

Serigne Ibra Mbacke DIENG, Amadou Jarouga Diallo, Alioune Dior FALL, Kady Diatta-Badji, William Diatta, Abdou Sarr and Emmanuel Bassene

Abstract
Watermelon, fruit of *Citrullus lanatus* (Cucurbitaceae), is well consumed in Senegal. The purpose of this study is to evaluate the total polyphenols and flavonoids contents of the red flesh and the white part of watermelon peels.The total polyphenols contents are estimated by the Folin-Denis and flavonoids by a method using $AlCl_3$. Polyphenol contents were 63.33± 1.455 mg TAE/g and 47.3 ±0.888 mg TAE /g dry extract respectively for the white part of the peels and red flesh. For flavonoids, there are respectively, 1.105 ± 0.142 mg RE/g and 2, 028 ± 0.061 mg RE/g. The results show that flavonoids are more concentrated in the red flesh whereas the peels are more riche in total polyphenols. Several studies show that consuming foods rich in polyphenols reduces the development of many pathologies. Man could thus consume, in the same way that the flesh, the white part of the peels.

Key words: citrullus lanatus, cucurbitaceae, red flesh, peels

Introduction
Fruits play an important role in nutrition and human health. Their consumption is a source of vitamin C, vitamin A, folates and potassium [1]. It also helps prevent some cardiovascular diseases and some cancers and nearly 3 million deaths a year worldwide [2-3].
Furthermore, according to Hooper [4], there is an improvement in some cardiovascular risk factors after consuming foods or drinks containing a high content of polyphenol.
It is in this context that we are interested to evaluate the content of polyphenols and flavonoids of the fruit of *Citrullus lanatus* called watermelon of the family Cucurbitaceae. It is a seasonal fruit very rich in water and well consumed in Senegal. Studies on watermelon seeds show antioxidant, anti-inflammatory, analgesic activity [5]. The fruit is used as a refreshing, aphrodisiac, diuretic, expectorant, digestive stimulant and the seed are tonic for the brain [6]. The watermelon juice has an antioxidant activity and inhibits the formation of peroxide [7].
In Senegal, only red flesh is consumed, the rest is reserved for domestic animals or thrown away. This study aims to compare the red flesh and the mesocarp (White flesh) of watermelon in order to evaluate the most beneficial part by comparing their contents of total polyphenols and flavonoids.

Material and Methods
Plant material
Watermelons are bought at the market known as Sandika of Pikine. They are washed and divided into several slices. Get rid of from their seeds, the red flesh is separated from the white part.

Reagents and equipment
Folin and Denis Reagents, $AlCl_3$ and Rutin are supplied by the Sigma Aldrich laboratory. Tannic acid comes from the Panreac laboratory. The absorbances are measured using a BioSystem BTS / 340 UV / Vis spectrophotometer and extraction using a Kenwood Chef Classic brand blender.

Extraction
Red flesh
1894 g of red flesh are first pressed for 10 min and the juice obtained is separated from the

marc by filtration. The latter is subjected to a second extraction by aqueous decoction for 30 minutes. Decocted and juice are combined and concentrated in vacuo, the residue is then dried in a drying oven for 48 hours at 45 °C.

Mesocarp or White Flesh

A quantity of 1111 g is dried first in an oven for 1 week at 45 ° and then reduced to powder. The latter is subjected to an aqueous decoction for 30 minutes. The decoctate obtained is concentrated under vacuum and then dried in an oven for 48 h at 45 ° to obtain a dry extract.

Phytochemical screening

The presence of the main chemical groups in the extracts was investigated using the tests described by Bassene [8]: Flavonoids (Shibata test), tannins (Stiasny reaction followed by $FeCl_3$), anthracenosides (Borntraeger test), alkaloids (Dragendorff's reagents), cardiotonic heterosides (Baljet, Kedde and Raymond-Marthoud reagents) and saponosides (moss index).

Total polyphenol contents

The total polyphenol content is determined according to the described method [8]. For it, the stock solutions (3 g in 100 ml of water) are first diluted to 1/100 and then to 2 ml of this solution are added 2 ml of the Folin-Denis reagent. Shake and let stand for 3 minutes before adding 2 ml of the 25% sodium carbonate solution. After 2 hours incubation without light, the samples are centrifuged at 4000 rpm for 4 minutes. The absorbances are then measured at 670 nm. The tests were repeated three times for each sample. A calibration range (0.005 - 0.05 mg / ml) is carried out with tannic acid and is treated in the same manner as the extracts. The results are expressed in mg tannic acid equivalent per gram of dry extract (mg TAE / g).

Flavonoid contents

The flavonoid dosage is carried according to the method of Gloria [9]. The stock solutions are diluted 1/10. Then 2 ml of 2% $AlCl_3$ in ethanol are added to 2 ml of this solution. After 1 hour of incubation at ambient temperature, the absorbances are measured at 405 nm. A calibration range (0.0125-0.4 mg/ml) made with Rutin is treated in the same way as the extracts. The results are expressed in mg Rutin equivalent per gram of dry extract (mg RE/g).

Results

Phytochemical screening

The yield obtained after extraction of the red flesh is 6.8% while that of the white part is 0.8%.

The screening shows the presence of polyphenols and flavonoids both in the flesh and in the white part. On the other hand, the saponosides are found in the red flesh, whereas in the mesocarp they are in a trace state. Cardiotonic, tannins, alkaloids and anthracenics are absent.

Total polyphenols and flavonoids

The total polyphenols contents, obtained from the tannic acid calibration curve ($y = 26.73x-0.158$, $R^2 = 0.991$), are 63.33 ± 1.45 mg TAE / g dry extract and 47 , 3 ± 0.88 mg TAE / g dry extract respectively for the mesocarp and the red flesh (figure 1).

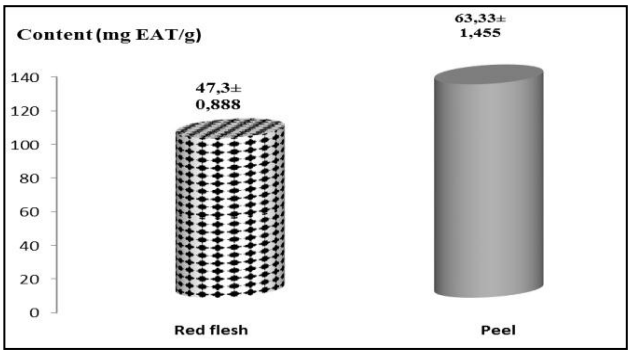

Fig 1: Polyphenols contents of watermelon

On the other hand, for flavonoids, from the calibration curve ($y = 26.73x - 0.158$, $R^2 = 0.991$), a content of 2.02 ± 0.06 mg RE/g of dry extract and 1,10 ± 0.14 mg RE / g of dry extract respectively for the red flesh and the mesocarp (figure 2).

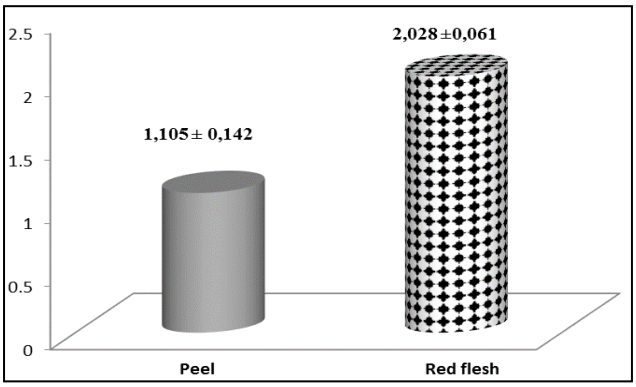

Fig 2: Flavonoids contents of watermelon

Discussion

A difference in extraction yield is noted between the different parts of the fruit. This could be due to the fact that the red flesh is richer in water-soluble compounds such as sugars whereas the white part is rich in fiber [10]. The presence of polyphenols and flavonoids could be explaine the described activities of watermelon. Based on some studies, some researchers affirm that *Citrullus lanatus* possesses antimicrobial, antiulcer, antioxidant, anti-inflammatory, laxative, analgesic activities [11].

This work shows that the contents of total polyphenols and flavonoids differ according to the parts of the watermelon studied. In fact, the flavonoids are more concentrated in the flesh whereas the mesocarp, on the other hand, is richer in total polyphenols.

These results confirm the richness of the watermelon in total polyphenols and in flavonoids. Compared to the study on the mango peels [12] (0.06 mg gallic acid equivalent / g) and that on the apple peels [13] (2.58 mg gallic acid equivalent /g), the polyphenol content of the white flesh of the watermelon is greater than that of the peels of mango and apple.

In the light of the results obtained, the human could thus, like red flesh, consume the white flesh of watermelon to benefit mainly from the supply of total polyphenols, to prevent certain diseases. Several studies have shown that the consumption of foods rich in polyphenols reduces the development of many pathologies, such as cancer, cardiac ischemia, atherosclerosis and hypertension [2-14-15-16-17].

Conclusion

The evaluation of the aqueous extracts of the different parts of the watermelon studied showed variable results. If the flesh is richer in flavonoids than the white part of the mesocarp, this is not the case for total polyphenols which, on the contrary, are more concentrated in the mesocarp.

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