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RESEARCH ARTICLE

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Cooking process effect on nutritional value of *Sesuvium portulacastrum* L. leaves in Senegal

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Abstract

Background: Leafy vegetables play an important role by contributing to most nutrients intake for health and human well-being. Some of these leafy vegetables are cooked before consumption. But the effect of the cooking process on the nutritional value of leafy vegetables is not well known. This research aimed to evaluate the effect of the cooking process on the nutritional value of *Sesuvium portulacastrum* leaves. To do that, fresh leaves were collected, air dried and divided into raw and cooked. The raw and cooked samples were analyzed to determine the physico-chemical properties (pH, humidity, ash, polyphenols, tannins and proteins) and minerals (nitrogen, calcium, magnesium, sodium and potassium).

Results: Based on physico-chemicals, the raw and cooked leaves contained a good concentration of polyphenol (155.58 mg $\pm$ 14.98 and 53.45 mg $\pm$ 10.97), tannin (107.62 mg $\pm$ 9.8 and 59.59 mg $\pm$ 4.17), nitrogen (0.41% $\pm$ 0.02 and 0.38% $\pm$ 0.02) and protein (2.59% $\pm$ 0.12 and 2.38% $\pm$ 0.14). The cooking process caused the loss of nitrogen (N), proteins, tannins and polyphenols from 8% to 66%. *S. portulacastrum* leaves contented also an important proportion of minerals. The raw and cooked contained sodium (30% and 21.28%), potassium (30% and 13.08%), magnesium (16.71% and 19.9%) and calcium (6.5% and 24%). The cooking process increased and reduced significantly calcium (270.42%) and potassium (56.42%), respectively.

Conclusion: *S. portulacastrum* leaves were an important source of nutritional value that could contribute to improved health and well-being.

KEYWORDS

cooking process, leaves, mineral, physico-chemical, *Sesuvium portulacastrum*

INTRODUCTION

Vegetables are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients, which can be successfully utilized to build up and repair the body. They are valued mainly for their high carbohydrate, vitamin and mineral contents. There are different kinds of vegetables, which may be edible as roots, stems, leaves, fruits or seeds. Each group contributes to diet in its own way.[1] Leafy vegetable leaves play an important role in human well-being. Among the leafy vegetables, there is *Sesuvium portulacastrum* leaves, which have important environmental, medicinal and alimentary virtues.[2]

S. portulacastrum belongs to the family Aizoaceae, facultative, naturally growing in the subtropical, Mediterranean coastal, and warmer zones of the world, which is native to Africa, Asia, Australia, North America and South America, and has naturalized in many places.[3,4] It is also used in ornamentation landscaping, desert greening and sand dune fixation.[5] This plant has good potential to be used for desalination of salt-affected soils or reclamation of saline soil.[6,7] *S. portulacastrum* is a perennial halophyte with medicinal properties and esthetic value and it produces industrially important ecdysones besides having significant

FIGURE 1 Fresh leaves of *S. portulacastrum*

tolerance to heavy metals.[2] The leaves of *S. portulacastrum* have been identified as a useful source to procure natural antimicrobial and antioxidant agents for human health.[8] The leaves are also utilized as a vegetable by the local people as well as forage for domestic animals in the coastal area.[4] The leaves are utilized as a wild vegetable crop in India, Southeast Asia and Africa.[9,10] In Senegal, dried leaves of Sesuvium are cooked and consumed as salad.[11]

However, despite the importance of these leaves of *S. portulacastrum*, they are more or less neglected by the population because they are consumed only in the southern zone of Senegal. The dried leaves are cooked three times to decrease their acidity and consumed as salad. It is cooked in a way contrary to certain leafy vegetables, particularly lettuces (e.g., salad, cabbage). Although the cooking process has opened the way to the consumption of plant foods which, without cooking, would have been non-digestible and sometimes even toxic. It is obvious that heat treatments have an impact on their nutritional values.[12] Moreover, the impact of the cooking process on the nutritional value of leafy vegetables is not well known. This study aimed to document the effect of the cooked process on nutritional value of *S. portulacastrum* leaves.

MATERIAL AND METHODS

Vegetal material collection

The fresh leaves of *S. portulacastrum* (Figure 1) were collected from Ziguinchor Province. Three samples of fresh leaves of *S. portulacastrum* were collected in the transitory zones between rice fields and mangrove of Goumel in Ziguinchor and Tobor (Figure 2).

Plant extract preparation

The fresh leaves were cleaned properly to remove all the waste particles and were air dried (Figure 3). The dried leaves were divided into two groups (raw and cooked). The dried leaves of *S. portulacastrum* were boiled three times and dried after cooking. Dried raw and cooked leaves were crushed with a blender and stored in plastic containers before being analyzed.

Physico-chemical and mineral analysis

The dried raw and cooked leaves were analyzed at the Laboratoire d'analyze et essai of Ecole Supérieure Polytechnique UCAD de Dakar. Physico-chemical properties (pH, humidity, ash, sugars, polyphenols, tannins and proteins) and minerals (nitrogen, calcium, magnesium, sodium and potassium) were of *S. portulacastrum* leaves were determined.

To determine pH, shredded leaves were mixed with distilled water, and the homogenized solution was measured directly with a pH meter. Samples were dried at 105°C in an isothermal oven during 24 h and the humidity was determined. The samples were incinerated at 525 ± 25°C for 4 h using a muffle furnace to determine the ash. Total sugars are evaluated by acid hydrolysis (HCl) in accordance with the LuffSchoorl method.[13]

Analytical methods were used to separate, identify and quantify nutritional components. Polyphenols, tannins and sugars were analyzed by a separation technique using the spectrophotometric method. The method consists of oxidizing the oxidizable groups of phenols in a basic medium by the method of Folin–Ciocalteu developed by Georgé et al.[14] Tannins were determined by the colorimetric method of Folin Denis, described by Joslyn.[15]

Proteins were determined using fluorimetry (fluorescence spectroscopy or spectrofluorimetry).

Minerals were analyzed by concentration determination using Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Emission (ICP). Nitrogen and protein content are determined by the Kjeldahl method.[16]

Statistical analysis

Data collected were subjected to two-way analysis of variance (ANOVA) performed with R 4.1.3.[17] When effects were significant,

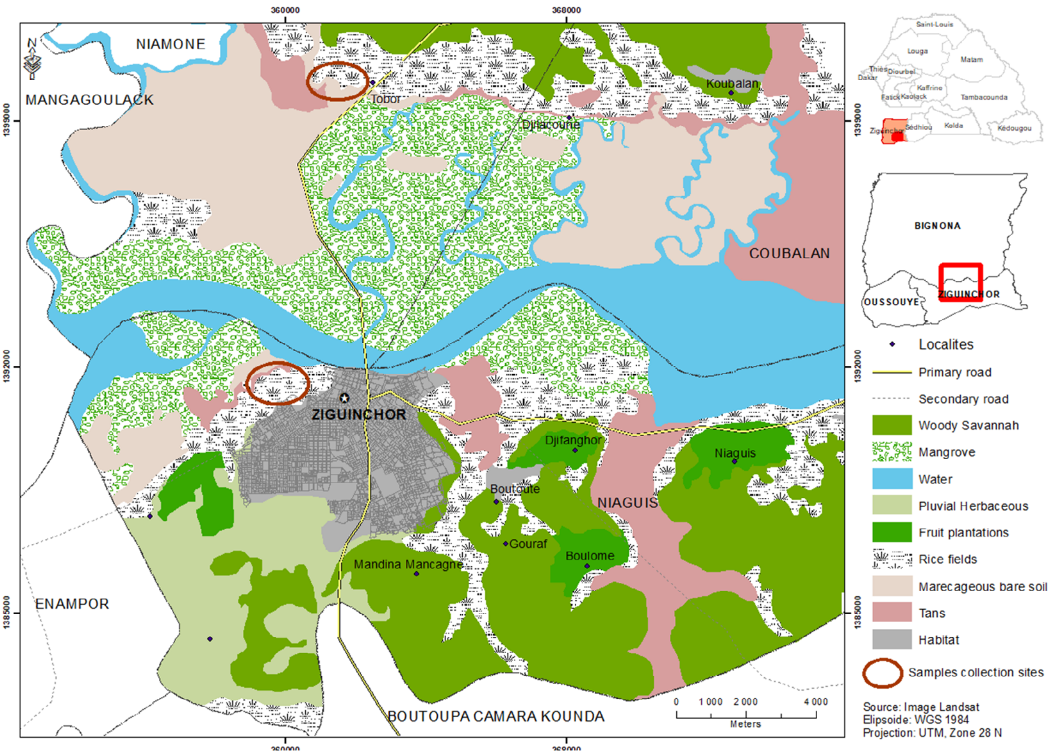

FIGURE 2 Localization of collected samples

Tukey's test was used for multiple mean comparisons to detect the significant differences between the status (Raw and Cooked). Statistical significance was fixed at 0.05. Considering the two status, all data are hence expressed as overall means ± SE.

RESULTS

Physico-chemical parameters

Cooked leaves were rich in polyphenol (53.45 mg ± 10.97), tannins (59.59 mg ± 4.17) and proteins (2.38% ± 0.14). But the higher values of polyphenol (155.58 mg ± 14.98), tannins (107.62 mg ± 9.85) and Protein (2.59% ± 0.12) were found in raw leaves. pH, Ash, polyphenols and tannins were significantly influenced ($p < 0.05$) by the cooking process. The decrease of physico-chemical parameters caused by the cooking process varied from 8% to 66%. The loss of nutrients was more important for polyphenol (65.64%), ash (51.59%) and tannin (44.62%). The boiling increased the humidity (48.41%). It had less effect on nitrogen and protein (8.33%) loss (Table 1).

Minerals

Mineral quantitative analysis of cooked and raw leaves of *S. portulacastrum* showed an important content of calcium, magnesium, potassium and sodium. The cooked leaves contained more

FIGURE 3 Dried leaves of *S. portulacastrum*

TABLE 1 Physico-chemicals content of *S. Portulacastrum* according the status (raw and cooked)

	Status		
Physico-chemicals	**Cooked**	**Raw**	***p***
pH	5.80 ± 1.93[a]	6.2 ± 2.07[b]	0.0232
Humidity (%)	9.84 ± 0.17[a]	6.63 ± 0.36[b]	1.04 e−05
Ash (g/100 g)	15.07 ± 1.31[a]	31.13 ± 0.34[b]	3.37 e−07
Polyphenols (mg/100 g)	53.45 ± 10.97[a]	155.58 ± 14.98[b]	2.62 e−04
Tannins (mg/100 g)	59.59 ± 4.17[a]	107.62 ± 9.85[b]	0.00116
Nitrogen (%)	0.38 ± 0.02[a]	0.41 ± 0.02[a]	0.273
Proteins (%)	2.38 ± 0.14[a]	2.59 ± 0.12[a]	0.273

Results are expressed as mean ± SE, letters a and b are groups (groups with different letters are significantly different).

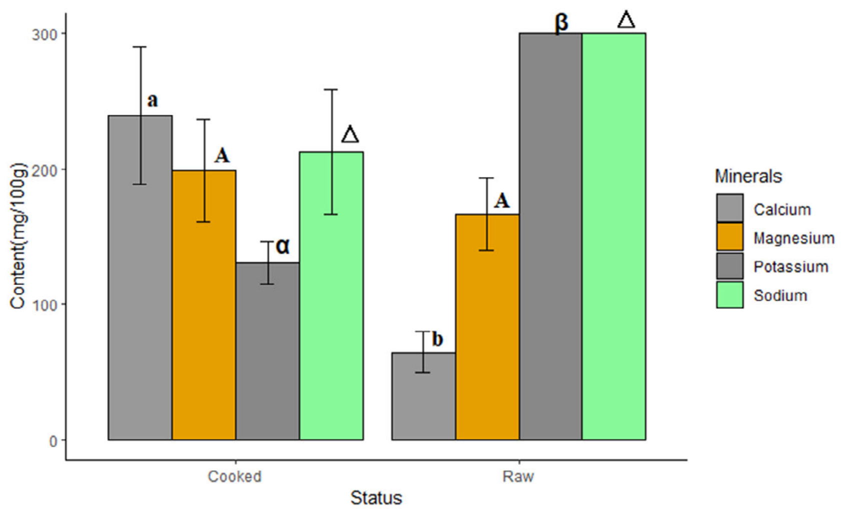

FIGURE 4 Mineral content of raw and cooked leaves of *S. Portulacastrum*

calcium (239.32 mg ± 50.95) and magnesium (198.81 mg ± 38.04) than raw leaves with respectively 64.61 mg ± 15.13 and 167.16 mg ± 26.72. While the higher content of sodium (300.01 mg ± 0.008) and potassium (300.09 mg ± 0.04) was found in raw leaves. However, the cooking process increased and reduced significantly the calcium (270.42%) and the potassium (56.42%), respectively (Figure 4). The effect of the cooking process was not significant for magnesium and sodium content. But there was a slight increase in magnesium (18.93%) and decrease of sodium (29.07%).

DISCUSSION

Physico-chemicals

The physico-chemicals detected from the raw and cooked leaves of *S. portulacastrum* have been shown to have great potential for ash, polyphenol, tannin and protein contents. The presence of these physico-chemicals was proven by many qualitative researches.[18–20] The Ash content in *S. portulacastrum* leaves varied between 1.92% and 54.5%.[21,22] An important content of Polyphenol in *S. portulacastrum* was found to the 0.89 g/100 g[23] and 0.57 mg/ml ± 0.010.[24] *S. portulacastrum* leaves contained also an important quantity of Tannin 0.17 mg/ml ± 0.019.[24] An important content of protein varying between 1.57% and 7.78% was in *S. portulacastrum* leaves.[24]

Minerals

This research showed that *S. portulacastrum* leaves had a rich content of minerals. The most important minerals founded in *S. Portulacastrum* leaves were Sodium, potassium, magnesium, calcium and nitrogen. It has been found an important proportion of minerals (37.65%) in *S. portulacastrum* leave.[22] The predominance of sodium (2.94–12.3) followed by magnesium (0.41–2.46), potassium (0.10–0.74) and calcium (0.14–0.32) were documented.[21] Das and Ghase[25] had found an important content of potassium (1.609) and sodium (3.174).

Effect of cooking process on physico-chemicals and minerals

The cooking process is responsible for chemical modifications in vegetables, whether due to the sensitivity of photochemical to heat, whether to nutrient losses inherent to leaching. Seeking prevention or minimization of these effects, some treatments are often applied to vegetables prior to the duration cooking process. The cooking process was described as unfavorable since nutrients such as polyphenol, tannin, ash, protein, nitrogen, potassium and sodium contents were negatively affected. It caused significantly the loss of ash, polyphenols and tannins content. The cooking process increased humidity, calcium and magnesium contents. Cooking vegetables affects the nutritional value and the effects depend on many conditions, such as the amount of heat, cooking pressure, moisture used, time of cooking, and other factors that will affect the end product.[26] The reduction in content of total polyphenols and tannins caused by microwave cooking velvet beans is significant (87.5% and 69.9%), respectively.[27] Smoking of oil also significantly decreased the total polyphenols content in the oils, thereby decreasing their antioxidant nutritive values.[28] No significant changes were found in protein and ash content after artificial drying.[29] Raw groundnut is more advantageous in nutritional value than roasted, while the roasted one is also advantageous in mineral contents than raw groundnut. Raw groundnut showed a good source of sodium, and dried and roasted groundnut is a good source of magnesium, potassium and calcium.[30] The mineral content of maize grain had different results from the heating period. The values of Ca, Mg and P increased with an increase in heating time compared to the control. On the other hand, the N value decreased.[31]

CONCLUSION

S. portulacastrum leaves had a rich content of polyphenol, tannin, protein and minerals. The nutritional content of *S. portulacastrum* leaves was changed through the cooking process. There was an increase in the content of calcium and magnesium and the humidity due to heating (cooking process). The cooking process decreased the nutritional value of polyphenol, tannin, protein, nitrogen, potassium and sodium. It is necessary to control the duration of cooking to reduce the loss of most of the important nutrients.

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CONFLICT OF INTEREST

The authors (Antoine Sambou, Nicolas Ayessou and Aly Diallo) certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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