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RESEARCH ARTICLE

STUDY OF COOKING PARAMETERS ON THE DEGRADATION OF ASCORBIC ACID CONTAINED IN GREEN LEAFY VEGETABLES PRODUCED AND CONSUMED IN THE KARA REGION-TOGO

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Abstract

The purpose of this study is to quantify the content and investigate the effects of cooking temperature and time on the variability of vitamin C content in six green leafy vegetables: Solanum macrocarpon, Hibiscus sabdarifa, Octimum gratissimum, Vernonia amygdalina, Adansonia digitata and Corchorus olitotius. Two methods were used to determine the vitamin C contents of the samples processed by blanching and boiling at different cooking times. With the iodometric method, Hibiscus sabdarifa (0.5368 mg/g) and Adansonia digitata (0.5016mg/g) have the highest vitamin C contents, while Octimum gratissimum has the lowest concentration of 0.1760 mg/g. The results of quantification obtained by the spectrophotometric method present practically the same results as those of the iodometric method with as light decrease of 0.0242 mg/g for Hibiscus sabdarifa and an increase of 0.0147 mg/g for Adansonia digitata. The results of the study of the effect of temperature and cooking time, whatever the method, showed with the blanching, a loss of rate of 30,21% in vitamin C for Hibiscus sabdarifa and Solanum macrocarpon a loss of rate of 4,25%. The degradations were more considerable during the boiling of 15 min with maximum losses in the order of 79,05% for the leaves of baobab boiled and 45,24% respectively for Adansonia digitata and Solanum macrocarpon.

Introduction:-

Diets rich in fruits and vegetables are widely recommended for their health-promoting properties [1-3]. Fruits and vegetables are major sources of certain micronutrients (vitamins, minerals), fiber, and a wide range of phytochemicals that, individually or in combination, are beneficial to human health [4] [5]. Diets rich in fruits and vegetables reduce the risk of obesity [6] [7], diabetes [8] [9], cardiovascular diseases [10-12] and certain cancers [13-15]. Antioxidants and other phytochemicals present in foods are the main protectors against these diseases. L-ascorbic acid, also known as vitamin C, is the most abundant soluble antioxidant in fruits and vegetables and is also an essential nutrient for humans and some other animals [16].

The human body is not able to synthesize vitamin C, so the best source of supply is food. Fruits and vegetables provide 69 to 73% of daily requirements [17]. Vitamin C in physiological doses is therefore an essential dietary component of human nutrition and the proper functioning of the body. It is a water-soluble antioxidant that plays an

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important role in the assimilation of non-heme iron [18] [19]. It is also responsible for the formation of collagen [20], the neutralization of free radicals and the healing of wounds, and is involved in the control of bacterial and viral infections [21] [22]. Prolonged vitamin C deficiency in humans leads mainly to scurvy [23], the symptoms of which range from exhaustion to bleeding of the gums and skin [23-25]. The degradation of ascorbic acid depends on many factors such as oxygen, light [26], temperature and storage time [27]. Thus, many fruits and vegetables contain vitamin C, but the vitamin C in vegetables is less available due to various processing methods, including cooking [28]. Indeed, some vegetables can be eaten raw, but most are usually cooked before consumption. However, because vitamin C is water-soluble, it quickly leaches into the cooking water and is destroyed during high-temperature cooking [28] [29].

The objective of this study is to quantify vitamin C and determine the effect of temperature and cooking time through blanching and boiling on its content in green leafy vegetables produced in the Kara region of Togo.

Material and Methods:-

Sample preparation

Six local vegetables most consumed in the Kara region were selected and purchased at the new market of Kara city. They are Solanum macrocarpon (Spinach), Hibiscus sabdarifa (Sorrel leaves), Octimum gratissimum (Basil), Vernonia amygdalina (Vernonia), Adansonia digitata (Baobab leaves) and Corchorus olitotius (Vegetable cortea). Each vegetable was subjected to the following treatment: The vegetables were blanched by immersion in a volume of boiling water (200 mL) at a temperature of 100°C for a period of one minute. After blanching, the samples were cooled in the open air. The vegetables were cooked at a temperature of about 85°C for varying lengths of time. After cooking, the samples were cooled in the open air. After cooling, each sample was placed in a clean, dry box.

Sample preparation and chemical analysis of vitamin C

Each vegetable (100g), after blanching or cooking is ground with distilled water. The obtained mixture is filtered through a Whatman paper and the filtrate obtained is determined by the iodine nitration and spectrophotometry (G10S UV-visible at the wavelength of 245 nm) methods

Results and Discussion:-

Vitamin C content in vegetables

The vitamin C contents of raw (uncooked) vegetables, determined by the iodometric method (IM) and spectrophotometric method (SM) are shown in Table 1 and Figure 1. The results show that, regardless of the method, sorrel leaves, baobab leaves and vernonia contain the highest vitamin C content with more than 50 mg/100g while African basil contains the lowest concentration with about 18 mg/100g. These results are slightly lower than those observed in the Burkina Faso Food Composition Table (baobab leaves: 52 mg/100g; sorrel leaves: 54 mg/100g). A difference that could be explained by the methods and conditions of analysis, the nature of the vegetables or by the transport and packaging. The Figure 1 shows that with in the measurement errors, the two dosing methods give approximately the same results, regardless of the dosing method used.

Table 1:- Vitamin C content***(mg/100g)*** in raw vegetables according to the two analytical methods.

	Raw vegetables					
Methods	**Sorrel**	**Baobab**	**Vernonia**	**Spinach**	**Vegetable cortea**	**Basil**
IM	53,68 ± 0,05	50,16 ± 1,02	49,28 ± 0,09	46,20 ± 1,01	36,96 ± 1,21	17,60 ± 0,12
SM	51,26 ± 0,02	51,63 ± 2,63	50,81 ± 4,30	47,48 ± 1,41	37,11 ± 1,78	17,70 ± 0,96

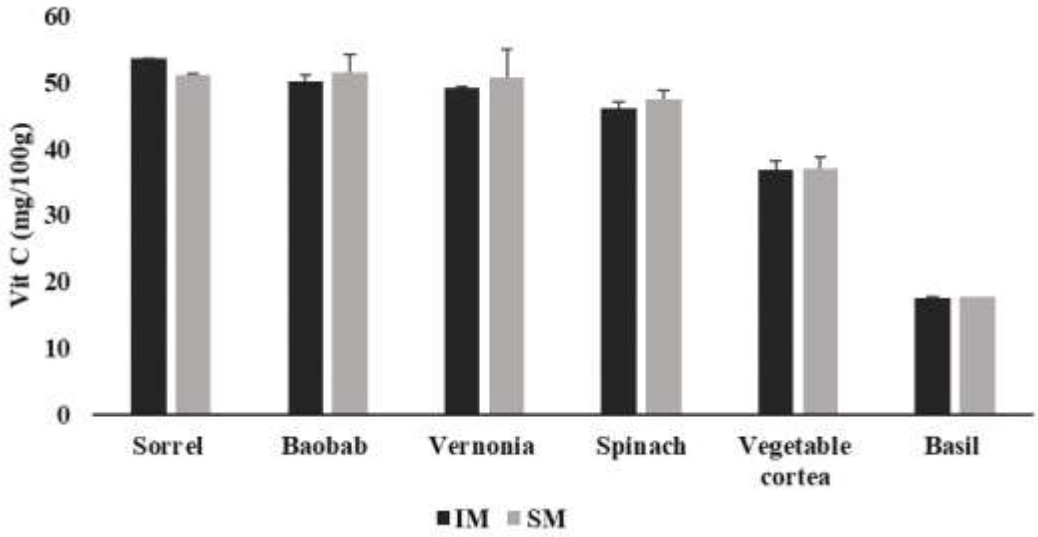

Figure 1: Vitamin C content in the studied vegetables according to the two assay methods

Effect of temperature

The vitamin C contents of vegetables blanched for 1 min at 100 °C, determined by the iodometric and spectrophotometric methods are shown in Table 2. The results show that, whatever the method, baobab leaves contain the highest vitamin C content after blanching, with nearly 48 mg/100g, followed by vernonia and spinach leaves, which contain about 45 mg/100g. The leaves of African basil remain the leaves containing the lowest concentration of vitamin C with 16.70 mg/100g. The results obtained by the iodometric and spectrophotometric methods are approximately the same, with the exception of measurement errors, which allows us to say that both methods are valid for the determination of vitamin C in vegetables.

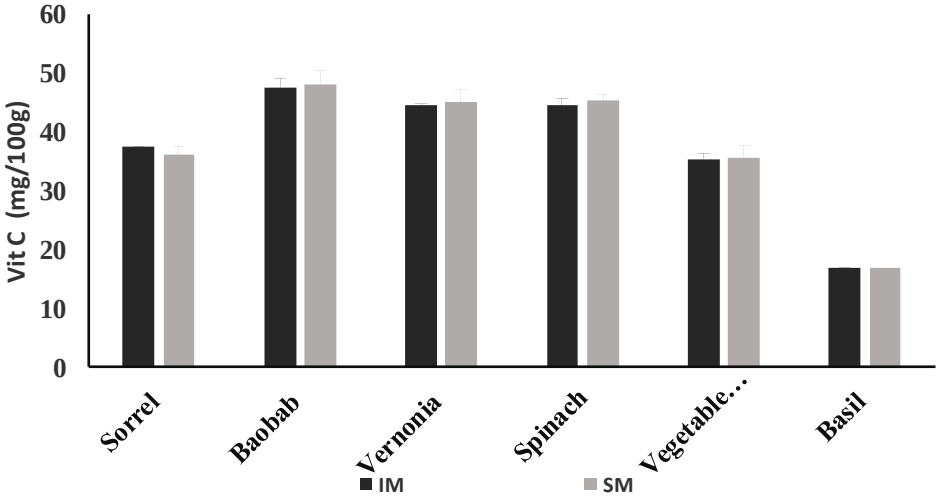

Figure 2:- Comparison of vitamin C content in raw and blanched vegetables (iodometric determination).

Table 2:- Vitamin C content***(mg/100g*** (by both methods of analysis) in vegetables that have under gone blanching (1 min at 100°C).

	Raw vegetables					
Methods	**Sorrel**	**Baobab**	**Vernonia**	**Spinach**	**Vegetable cortea**	**Basil**
IM	37,22 ± 0,02	47,52 ± 1,40	44,44 ± 0,10	44,44 ± 0,98	35,20 ± 0,99	16,72 ± 0,10
SM	36,00 ± 1,41	47,85 ± 2,58	44,81 ± 2,40	45,26 ± 0,98	35,41 ± 2,09	16,66 ± 0,01

The comparison of the vitamin C content in raw and blanched vegetables is shown in Figure 2. It can be seen that heat affects the vitamin C content of all vegetables. However, not all leaves react to heat in the same way. It appears that sorrel leaves are the most affected by blanching. In fact, we go from more than 50 mg/100g of vitamin C in the raw vegetable to 37 mg/100g in the blanched vegetable, a vitamin loss of nearly 30%. Vernonia loses nearly 12% of vitamin C during blanching and other vegetables suffer a loss of between 3 and 7%.

Effect of cooking time

Cooking in water affects the vitamin C content of all leafy vegetables (Tables 3 and 4, Figures 3 and 4). Vitamin C levels in raw vegetables are higher compared to those in heated vegetables. As the heating time increases, the vitamin C content decreases, while the temperature remains relatively constant around 85°C. This is due to the fact that vitamin C is water soluble and easily destroyed by heat.

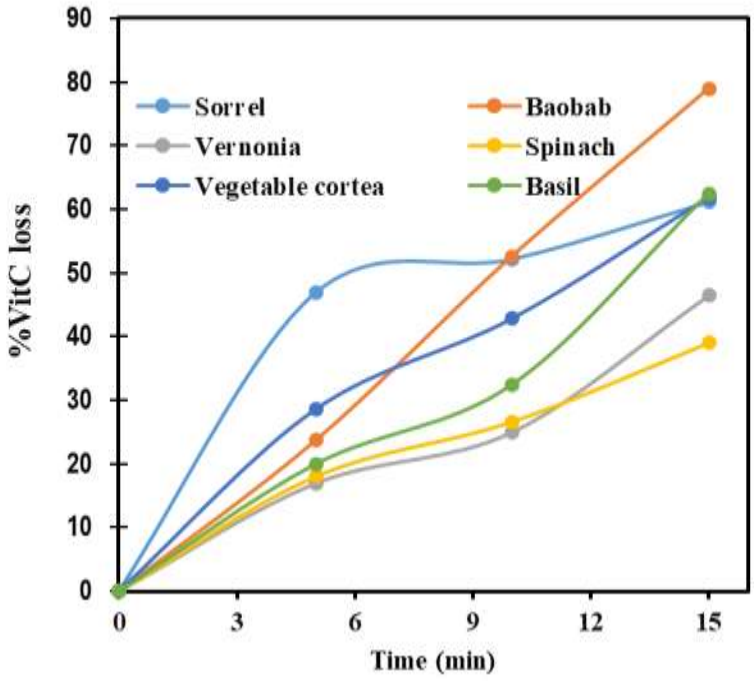

Figure 3: Evolution of vitamin C rate (determined by iodometry) lost in vegetables as a function of cooking time (at 85°C).

Table 3: - Effect of cooking time at 85°C on vitamin C content(mg/100g).

Vegetables	Cooking time (min)	Iodometric method	Spectrophotometric method
Sorrel leaves	0	53,68 ± 0,05	51,26 ± 0,02
	5	28,51 ± 0,20	28,74 ± 2,01
	10	25,61 ± 0,03	24,29 ± 0,86
	15	20,85 ± 0,01	21,56 ± 2,50
Baobab leaves	0	50,16 ± 1,02	51,63 ± 2,63
	5	38,28 ± 0,95	38,37 ± 2,34
	10	23,76 ± 1,31	23,63 ± 1,86
	15	10,56 ± 1,61	10,81 ± 1,96
Vernonia	0	49,28 ± 0,09	50,81 ± 4,30
	5	40,92 ± 0,81	40,67 ± 3,03
	10	36,96 ± 0,78	36,44 ± 1,46
	15	26,40 ± 0,49	24,03 ± 3,10
Spinach	0	46,20 ± 1,01	47,48 ± 1,41
	5	37,84 ± 1,00	37,11 ± 0,47
	10	33,88 ± 0,85	32,29 ± 2,02
	15	28,16 ± 3,25	26,00 ± 2,34
Vegetable cortea	0	36,96 ± 1,21	37,11 ± 1,78
	5	26,40 ± 1,02	27,26 ± 2,10
	10	21,12 ± 0,97	20,45 ± 2,01
	15	14,08 ± 2,10	14,00 ± 2,14
Basil	0	17,60 ± 0,12	17,70 ± 0,96
	5	14,08 ± 0,90	14,51 ± 0,001
	10	11,88 ± 0,86	11,63 ± 0,99
	15	6,60 ± 2,11	5,48 ± 1,02

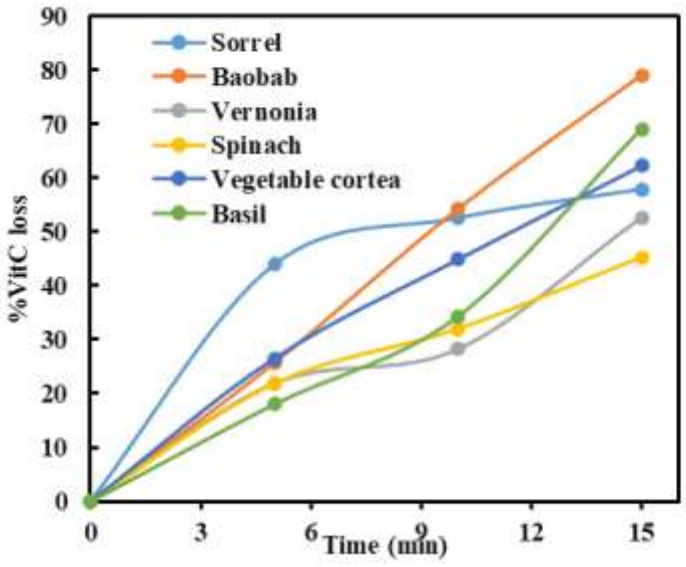

Figure 4:- Evolution of vitamin C rate (determined by spectrophotometry) lost in vegetables as a function of cooking time (at 85°C).

Table 4:- Percentage loss of vitamin C as a function of cooking time at 85°C using the two methods of determination

Vegetables	Cooking time (min)	%vitamin loss (IM)	%vitamin loss (SM)
Sorrel leaves	0	0	0
	5	46,89	43,93
	10	52,23	52,61
	15	61,16	57,94
Baobab leaves	0	0	0
	5	23,68	25,68
	10	52,63	54,23
	15	78,94	79,06
Vernonia	0	0	0
	5	16,96	21,92
	10	25,00	28,28
	15	46,43	52,70
Spinach	0	0	0
	5	18,06	21,84
	10	26,67	31,99
	15	39,04	45,24
Vegetable cortea	0	0	0
	5	28,57	26,54
	10	42,86	44,89
	15	61,90	62,27
Basil	0	0	0
	5	20,00	18,02
	10	32,50	34,29
	15	62,50	69,04

The greatest losses in both methods were observed in baobab leaves (78.94% to 79.06%) and sorrel leaves (57.94% to 61.16%) after 15 minutes of cooking. Thus, the vegetables that had a higher initial vitamin C content experienced the greatest losses. It would appear that the denaturation of vitamin C during heating depends on its availability in the vegetable [30]. Conversely, the lowest losses of vitamin C were observed in spinach (39.04% to 45.24%) and vernonia (46.43% to 52.7%) at 15 minutes. As spinach and vernonia leaves have a harder texture than the other leaves studied, it seems that the loss of vitamin C could also depend on the texture or the maturity of the vegetable. It can be seen for all the vegetables that as the heating time increases, the loss of vitamin C increases (Figure 3 and 4). Also at 15 minutes, vegetable cortea and basil lose about 60% of vitamin C. These losses are justified since denaturation of vitamin C is induced by a number of factors including cooking time and method, texture, and water solubility. Thus, because vitamin C is a water-soluble and heat-labile molecule, cooking significantly reduced the vitamin C content of vegetables. This result is similar to the work of Soro et al. (2022) who observed that heat treatments affected vitamin C levels in Hibiscus sabdarifa and Corchorus olitotius leaves [31]. However, blanching had less effect on vitamin C content compared to cooking (15 min), with a reduction of 4.59-4.76% versus 61.90-62.27% and 3.81-4.68% versus 39.04-45.24% respectively for vegetable cortea and spinach. Studies have reported that the average losses of spinach were 60% with boiling and could be as high as 77% for boiled vernonia species depending on the cooking time [32]. These losses are much higher than those obtained in this study, which may be due to the analytical conditions, time or the amount of cooking water.

Conclusion:-

This study determined the vitamin C content in the six green leafy vegetables most consumed in the city of Kara, namely Solanum macrocarpon, Hibiscus sabdarifa, Octimum gratissimum, Vernonia amygdalina, Adansonia digitata and Corchorus olitotius. Of all the vegetables, sorrel (53.68 mg/100g) and baobab (50.16 mg/100g) leaves have the highest vitamin C content. Our work also allowed us to know the influence of time and cooking method on these vegetables. It was clearly established that the more the cooking time in creases, the more the vitamin C concentration decreases, whatever, the vegetable studied with losses in vitamin C higher than 50% for most of the vegetables with a cooking time of 15 minutes.

These results led to the hypothesis that the loss of vitamin C during heating could depend onits availability in the vegetable on the one hand and ontheother hand, on the texture or maturity of the vegetable. Also, the evaluation of the effect of temperature clearly shows that in order to preserve the vitamin C in the best way, it would be better to blanch our vegetables with a small amount of water. However, as cooking is the most common treatment used in African cuisine, with long cooking times, it is recommended not to the cooking water but to use it for the rest of the preparation. Indeed, the vitamin C being water-soluble, it is most certainly foundin large quantities in the cooking water. Processing of most vegetables is unavoidable, so it is advisable to add fruit to daily meals, aswell as vegetables, to ensure a regular and adequate in take of vitamin C, in accordance with the WHO daily reference intake of 75 and 90 mg/day for women and men respectively. This in take can average up to 110 mg/day.

Conflicts of interest :-

The authors of this article declare that there are no conflict so finterest in this publication.

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