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RESEARCH ARTICLE

EFFECT OF COOKING TIME ON BIOCHEMICAL PROPERTIES OF RAFFIA (RAFFIA HOOKERI) HEART CONSUMED AS VEGETABLE IN CÔTE D'IVOIRE

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Abstract

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Raffia (Raphia hookeri Mann & Wendl.) heart, a little-known vegetable, is usually eaten after cooking in some regions of the Cote d'Ivoire. The proximate composition of the fresh state and the effect of cooking time (15, 30 and 45 min) on biochemical parameters were investigated. The results show that fresh raffia heart contains nutrients such as proteins (14.53 ± 0.03 g/100g), lipids (2.60 ± 0.10 g/100g), total sugars (35.61 ± 0.13 g/100g) and phytochemicals, in particular total polyphenols (5.86 ± 0.38 g/100g), flavonoids (0.75 ± 0.20 g/100g) and tannins (1.93 ± 0.9 g/100g). It is also rich in fibre (23.30 ± 0.75 g/100g) and ash (12.60 ± 0.02 g/100g), which contain minerals. Cooking for 15 minutes did not affect the protein content (14.53 ± 0.04 g/100g), but the content of total polyphenols (8.23 ± 0.39 g/100g), lipids (3.60 g/100g) and energy (295.84 ± 3.96 kcal/100g) increased by 28.79%, 2.77% and 0.74% respectively. Conversely, fibre (22.80 ± 0.67 g/100g), flavonoids (0.54 ± 0.10 g/100g) and tannins (1.19 ± 0.13 g/100g) decreased by 2.14%, 28% and 38.34% respectively. Except for lipids, the values of other nutrients decreased after 30 and 45 minutes of cooking. The nutrient values of raffia hearts cooked for 15 minutes are high, which could help to meet the body's needs. The heart of raffia hookeri traditional food resources is an important source of nutrients. The adoption of a good regeneration and domestication strategy could make Raffia hookeriavailable for large-scale food exploitation and as a source of financial returns.

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Introduction:-

In Côte d'Ivoire, as in many other African countries, forest resources derived from forest ecosystems have played an important role in the survival of both rural and urban populations for centuries (Moupela et al., 2011). These forest resources contribute to poverty reduction and food security for people in rural areas (Ouattara et al., 2016). Researchers have investigated some of the plants in these forest resources, sometimes limiting their scope or relying on simple inventories (Adou Yao et al., 2011; Koffi et al., 2015) This group includes palms belonging to the genus Raffia. They grow mainly in swampy areas, most of which are hydromorphic (Abrou et al. 2019). There are several species of raffia, but Raphia hookeri is the most common in Côte d'Ivoire, particularly in forested areas (west and south-west) Mollet et al (2000).

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Raffia, a Non-Timber Forest Product (NTFP), is widely known for its use as a fibre in horticulture for making hats, clothing and handicraft furniture, and for its stems or stalks used in the construction of traditional houses (Mouranche 1955). Traditional medicine also uses specific parts such as roots and fruits (Mbaka et al., 2013; Dada et al., 2017). The raffia palm yields several food products such as raffia heart, fruits, and raffia wine (Dransfield et al., 2020). The local population highly values the heart of the raffia palm, the inner part of the buds (Vanié-BI et al., 2021). However, only locals consume it, making it a little-known food. People in the Centre-West and west of Côte d'Ivoire consume the heart of the raffia as a vegetable in sauce (Kouamé et al., 2008).

Unlike raffia fruits and seeds whose nutritional composition has been of interest to several authors, mainly because of their high lipid content (Malumba 2013; Doungue et al., 2020; Liminguiet al., 2021), there is little or no information on the biochemical composition of raffia hearts. Researchers have not yet investigated the physico-chemical and nutritional properties of raffia hearts consumed as a vegetable in Côte d'Ivoire, nor the effects of cooking on this nutritional potential.The aim of this study is to highlight the biochemical potential and the effect of moist heat treatment on raffia hearts consumed in Côte d'Ivoire in order to enhance their value.

Materials and Methods:-

Biological material

The biological material on which the work was based consisted of raffia heart (Raphia hookeri). It's from the Zuenoula region (Côte d'Ivoire). It was transported in a cool box to the biotechnology laboratory of the Félix HouphouëtBoigny University (Abidjan, Côte d'Ivoire) to keep it fresh. We cut the raffia heart into small slices and washed it with distilled water. We used one part of the raffia heart in its fresh state for the work and cooked the other part at different times.

Treatment in the water-boiled state

Treatment in the water-boiled state was carried out according to the method described by Brou et al., 2018a. It consisted of placing 250 g of fresh raffia heart in 1.5 L of already boiling distilled water for 15, 30 and 45 min, respectively. After boiling, we drained and cooled it to room temperature. We then cut it into thin strips and dried it in an oven at 50°C for 48 hours. At the end of the oven drying process, the raffia core was crushed and sieved through a 100 µm mesh sieve. The powders obtained constituted the sample for the water-cooked state.

Analysis of the proximate composition of raffia heart

Quantification of moisture, ash, fibre and protein using the Kjeldahl technique, PH and titratable acidity were conducted following the standard procedures outlined in AOAC 1990. Lipids were determined using the soxhlet method described by AFNOR 1986. The FAO 2002 calculation method was employed to ascertain the total carbohydrate content based on dry matter. The expression of the carbohydrate content (1) and Energy value (2) are as follows :

Carbohydrates (g/100g DM) = 100 – (% moisture + % proteins + % lipids + % ash + % fibres) (1)
Energy value (kcal/100g DM) = (4 x % Carbohydrates) + (9 x % lipids) + (4 x % Proteins) (2)

After extraction of the sugars with water, the total sugars were determined by the method proposed by Dubois et al., 1956 using phenol and sulphuric acid. The method described by Bernfeld 1955 was used to quantify reducing sugars, which are revealed by 3,5-dinitrosalycilic acid (DNS).

Determination of total phenols

Phenolic compounds were extracted with methanol using Singleton et al., 1999method. One (1) mL of methanolic extract was added to 1 mL of 10% Folin-Cocalteu reagent. The mixture was left to stand for 3 min, then 1 mL of 20% (w/v) sodium carbonate solution was added. The contents of the tube were made up to 10 mL with distilled water. The whole tube was placed in the dark for 30 min and the the absorbance was read at 745 nm against a blank using a spectrophotometer (MILTON RAY, USA). A standard curve established with gallic acid (1 mg/mL) was used to determine the amount of phenols in the sample..

Flavonoid content

Flavonoids were determined using the method described by Meda et al., 2005**.**

To a volume of 0.5 mL of methanolic extract, 0.5 mL of distilled water, 0.5 mL of aluminium chloride, 0.5 mL of potassium acetate and 2 mL of distilled water were successively added. The mixture is left to stand for 30 min in the dark and the absorbance is read at 415 nm against a blank. The amount of flavonoids in the sample is determined using a standard solution of quercetin (0.1 mg/mL).

Tannin content

The modified vanillin method of Bainbridge et al., 1996was used for the determination of tannins.

In this experiment, a 1% concentration solution of vanillin reagent (consisting of 40% sulphuric acid and 0.1% vanillin) was mixed with 0.5 mL of methanolic extract (derived from raffia heart flour). After exposing the combination to darkness for 30 minutes, the absorbance was quantified at a wavelength of 500 nm. Quantification of tannin content is achieved using a standard series obtained from a stock solution of tannic acid (0.2 mg/ml).

Statistical analysis

In the present experiment, each test in the sample was analysed in triplicate. Data were expressed as mean ± standard deviation (SD). Differences between means were analysed by analysis using IMS SPSS Statistics 26. A statistically significant difference was found at $p < 0.05$.

Results and Discussion:-

The physico-chemical characteristics of the different samples of raffia hearts, fresh and cooked at different times, are presented in Table 1. For all of the parameters studied, statistical analysis shows a significant difference between the means at the 5% threshold. pH values ranged from 5.75 to 5.80 for CRH30 and FRH, respectively. There was a slight increase in moisture from fresh to cooked, as well as between the different cooking times, ranging from 89.81 to 91.35. The high-water content of fresh raffia heart (FRH) makes it a highly perishable food. High water content promotes enzyme activity, which could lead to high microbial activity (Onyeike et al 2008). The increase in water concentration rising from 90.47 ± 0.40 to 91.35 ± 0.2 g/100 g fresh weight after 15 and 45 min of cooking could be attributed to the softening of the cell wall, leading to water absorption by the cells (Brou et al., 2018 b).

Fibres content (23.30 ± 0.75 g/100 g) and ash (12.60 ± 0.02 g/100 g) decreased by about 2.14 % and 17.46 %, respectively, between the fresh and 15 min cooked condition. The values for 15 and 30 min cooking varied very little. The decrease could be explained by the diffusion of certain minerals, which make up the ash, into the cooking water (Bakhtiar et al., 2024). Contrary results for fibres were observed by Brou et al., 2018b, who worked on oil palm heart. However, our results are like those of Kouassi 2022, who worked on African asparagus, and Yuyama et al., 1999 who worked on pupunheira palm heart. The residual amounts of fibres (19.70±1,2) and ash (9.40±0.02) after 45 min of cooking, as well as that of the fresh product (23.30±0.75 g/100g and 12.60±0.02 g/100g), are very high. This high ash content may indicate that raffia heart is an excellent source of minerals, which play an essential role in the body. Minerals act as inorganic cofactors in metabolic processes (Heanacho et al., 2009). The fibres remaining after cooking are insoluble fibres, which play a crucial role in the body due to their effect on the digestive system and excessive absorption of cholesterol (Mensah et al., 2008). Indeed, consuming raffia heart can satisfy the daily requirement for fibres, estimated to be between 25 and 30 grammes (Depezay et al., 2006).

Cooking resulted in a decrease (6.87%) in carbohydrate content, ranging from 51.33±0.88 to 47.80±1.48g/100g, with the highest value for CRH15. Analysis of variance showed a significant difference ($p > 0.05$) between the means for the different cooking times. The CRH15 sample had the highest energy (295.84±8.22 kcal/100g) and carbohydrate (51.33±0.88) values compared to the other two cooking times. The decrease in energy could be explained by the decrease in carbohydrate and protein content. Heart of raffia is not a high-energy food, but its consumption would contribute to energy intake (Benmeziane-Derradj, 2019).

Table 1:- Physico-chemical parameters of fresh and boiled raffia hearts.

		FRH	CRH15	CRH30	CRH45
	pH	5.80±00d	5.78±00b	5.75±00a	5.79±00b
	Titratableacidity (meq)	35±0.07d	31±00c	29±0.1b	26±0.2a
Paramètres	Moisture (g/100 FB)	89.81±0.10a	90.47±0.40b	90.99±0.3c	91.35±0.2d
Physico-chimiques	Dry matter (g)	10.18±0.10d	9.53±0.40c	9.01±0.30b	8.65±0.20a

Fibres (g /100g DM)	23. 30±0.75d	22.80±0.67c	21.03±0.90b	19.70±1.2a
Ash (g /100g DM)	12.60±0.02d	10.40±0.10c	10.30±0.01b	9.40±0.02a

Means with different exponents on the same line are significantly different ($p < 0.05$).
FRH : fresh raffia heart ; CRH15 : cooked raffia heart 15min ;CRH30 : cooked raffia heart 30min ;CRH45 cooked raffia heart 45min

Biochemical analysis of raffia hearts revealed the presence of proteins and carbohydrates in high concentrations, in contrast to lipids (Table 2). Protein content variedbetween 14.10±0.48 to 14.53±0.04 g/100 g dry matter, with the fresh raffia heart (FRH) having the highest value. Protein content remains unchanged after 15 min cooking time. A decrease of 2.95% was observed after cooking for 45 minutes. Similar results were observed by Vodouhe et al., 2012. On the other hand, Benguendouz(2017) observed an increase in protein content when a leg of lamb was cooked. The values obtained in our study are higher than those of Brou et al., 2018a, who obtained results ranging from 10.7 ± 0.66 to 13.12 ± 0.69% for oil palm hearts. The decrease in protein content of our samples from 15 min of cooking could be explained by the fact that the food product impregnates in water and large quantities of soluble matter (amino acids) are released in the cooking water (Lund, 1988). The consumption of raffia hearts could help to meet the protein requirements of adults, estimated at 0.9 g/kg body weight/day (FAO/WHO, 2007).

The lowest lipid value (2.60±0.10 g/100 g) was obtained for FRH, and the highest value (4.60±0.23 g/100 g) was obtained for CRH45. Cooking led to an increase of 27.77% after 15 minutes and 43.47% after 45 minutes, likely due to water loss and the concentration of dry matter after cooking and drying. Biandolino et al., (2021) found a similar result in their study on fish cooking. Although an increase was observed, the levels remained low. According to several authors, vegetables are a poor source of fat (Tchiegang and Kitikil 2004).

Statistical analysis of the sugars showed that there was a difference between the sugar contents of the different samples. The values varied from 8.13±0.21 to 35.61±0.13 and from 0.32±0.12 to 1.28±0.16g/100g for total and reducing sugars, respectively. FRH showed the highest values. Of the three cooked samples, CRH15 showed the best profile. The reduction in reducing sugars was only 4.68% compared to 77% for CRH45. In addition, total sugars decreased by 0.66% compared to 77.16%. The decrease is thought to be due to the leaching of oses and water-soluble oligosides (Benguendouz 2017).

Table 2:- Biochemical parameters of fresh and boiled raffia heart (100g DM).

		FRH	**CRH15**	**CRH30**	**CRH45**
	Protein(g)	14.53±0.03c	14.53±0.04c	14.46±0.11b	14.10±0.48a
	Fat (g)	2.60±0.10a	3.60±00b	4±0.20c	4.60±0.23d
Biochemicalparameters	Reducingsugars (g)	1.28±0.16d	1.22±0.3c	0.75±0,10b	0.32±0.12a
	Total sugars (g)	35.61±0.13d	28.45±0.32c	15.44±0.11b	8.13±0.21a
	Total carbohydrates (g)	53.03±1.35d	51.33±0.88c	49.79±1.15b	47.80±1.48a
	Energy value (Kcal)	293.64 ±8.22c	295.84±3.96d	293±6.56b	289±2.77a

Means with different exponents on the same line are significantly different ($p < 0.05$).

FRH: fresh raffia heart ; CRH15 : cooked raffia heart 15min ; CRH 30 : cooked raffia heart 30min ; CRH45 cooked raffia heart 45min

The phytochemical parameters studied were polyphenol, flavonoid, and tannin content (Table 3). Statistical examination of the datarevealed a significant difference ($p > 0.05$). Polyphenol and flavonoid values for CRH15 were 8.23±0.39/100g and 0.54 ± 0.10g/100g, and for CRH45, they were 3.25 ± 0.30 g/100g and 0.45±0.10 g/100g, respectively. Tannin levels ranged from 1.93±0.19 g/100g (FRH) to 0.85±0.10 g/100g (CRH45). After 15 minutes of cooking, we observed a 28.79% increase in tannin content. This is thought to be due to a modification of the matrix by heat, resulting in synergy between molecules (Adefegha et al 2011). However, a reduction was observed after 30 minutes of cooking and even more after 45 minutes. The decrease could be explained by the diffusion of water-soluble polyphenols due to prolonged exposure to heat. CRH15 levels and residual levels after 30 minutes are high, which could be beneficial when consuming cooked raffia hearts. According to some authors, (Abdou, 2009; Rassouli et al., 2010), flavonoids and tannins significantly reduce total serum and liver cholesterol levels and protect blood vessels from cholesterolrelated damage. They may also help prevent oxidative stress-related problems, such as degenerative diseases, and assist in maintaining a healthy cardiovascular system (Li et al., 2017).

Table 3:- Phytochemical parameters of fresh and boiled raffia heart (100g DM).

		FRH	**CR 15**	**CR30**	**CR45**
	Total polyphenols (g)	5.86±0.38c	8.23±0.39d	5.95±0.19b	3,25±0,30a
Phytochemicalparameters	Flavonoids (g)	0.75±0.20d	0.54±0.10c	0.49±0.10b	0.45±0.10a
	Tannins (g)	1.93± 0.19d	1.19±0.13c	1.14±0.11b	0.85±0.10a

Means with different exponents on the same line are significantly different ($p < 0.05$).
FRH: fresh raffia heart; CRH15 : cooked raffia heart 15min ; CRH30 : cooked raffia heart 30min ; CRH45 cooked raffia heart 45min

Conclusion:-

Analysis of the biochemical composition of fresh raffia heart showed that it is rich in protein, fibre, carbohydrates, and phytochemicals, particularly total polyphenols, flavonoids, and tannins. Cooking for 15 minutes did not affect protein levels, but increased polyphenols, lipids and energy content. There was a slight decrease in flavonoids, total sugars, tannins, carbohydrates and fibre. The remaining amounts are still significant cooking for 30 and 45 minutes results in a significant loss of nutrients. It is best to cook for 15 minutes.

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