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Composition and nutritional profile of certain traditional dishes consumed in the department of *Man* (Côte d'Ivoire)

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Abstract

Malnutrition is still a problem in Côte d'Ivoire. This study determined the nutrients and nutritional profile of five traditional dishes consumed in western Côte d'Ivoire. The dishes are : « Tôh » of cassava with sauce based on *Byttneria catalpifolia* (TBC), « Tôh » of cassava with sauce based on *Beilschimidia mannii* (TBM), « Tôh » of cassava with sauce based on *Sesamum radiatum* (TSR), rice with sauce based on *Beilschimidia mannii* (RBM) and rice with sauce based on *Sesamum radiatum* (RSR). The analysis of biochemical compounds and minerals was carried out on samples from two periods of the year: the post-harvest period (October-February) and the lean period (July-September). The results showed that the water content of the food consumed during these two periods was average and ranged from 65.8±0.1 (TBM) to 71.9±0.2 (TSR) g/100g of fresh material. The contents of proteins, fats, total carbohydrates and raw fibres varied respectively from 3.2±0.2 (TBC) to 8.7±0.1 (RBM) g/100g dry matter, 2.1±0.2 (TBM) to 4.6±0.2 (TBC) g/100g dry matter, from 14.4±0.3 (RSR) to 23.1±0.1 (TBM) g/100g dry matter and from 1.6±0.2 (TBC) to 4.8±0.1 (TBC) g/100g dry matter. Protein and fibre contents were medium while fat and carbohydrate contents were low. As for mineral contents expressed in mg/100g of dry matter, they varied from 1124.7±0.1 (TBM) to 2367.8±0.1 (TBC) for sodium, from 114.6±0.0 (RBM) to 1583.9±0.1 (TBC) for potassium, from 316.6±0.2 (RBM) to 922.6±0.1 (TBC) for phosphorus, from 299±0.1 (RBM) to 1593.7±0.1 (TBC) for calcium, from 5±0.1 (TBM) to 12±0.1 (TSR) for iron. All these levels were high except for potassium, which was low. Iodine levels were average and ranged from 9.8±0.2 (TSR) to 13.4±0.2 (TBC) µg/100g. The nutrient profile showed that all dishes are classified in the group of foods to be consumed in small quantities. The dish TBM has the best profile as it has a low LIM score.

Keywords: Traditional foods, biochemical and mineral composition, nutritional profile, Côte d'Ivoire

1. Introduction

Food is a basic human need, providing the body with the nutrients and energy it needs to build and function (Rigaux, 2014) [24]. In both developing and developed countries, monitoring the quality of food is of paramount importance, given the numerous forms of malnutrition and their measurable consequences in terms of human lives (Becquey, 2006) [4]. The diet of many Africans consists mainly of staple cereals or tubers and includes few foods rich in micronutrients such as fruits, vegetables or animal proteins (Chastre *et al.*, 2009; World Bank, 2007a) [7, 26]. Globally, two billion people suffer from at least one micronutrient deficiency (Burchi *et al.*, 2011) [6]. An individual can quite easily consume enough calories without absorbing enough micronutrients. This leads to 'hidden hunger', as signs of micronutrient deficiency are more difficult to identify than other signs of malnutrition. Yet such a deficiency can lead to lasting damage to health, productivity and mental development (Micronutrient Initiative, 2009) [20]. In Côte d'Ivoire, there are no recent national data on micronutrient deficiencies. However, the prevalence of anaemia shows that iron deficiency remains widespread. It is the most common form of micronutrient deficiency. The prevalence of anaemia was estimated in 2012 at 75% among children under 5 years of age, 54% among women of childbearing age, and 30% among men aged between 15 and 49 years (INS/ICF, 2012) [13]. The objective of this study was to assess the nutritional security of rural households in the Department of *Man*. To achieve this objective, the biochemical and mineral composition and then the nutritional profile of five traditional dishes most consumed by rural households were determined.

2. Materials and methods

2.1 Biological material

The study material consisted of cassava (*Manihot esculenta*), rice (*Oriza sativa*), mucilage extract from the fresh bark of *Byttneria catalpifolia*, powder from the grains of *Beilschimidia mannii* and powder from the leaves of *Sesamum radiatum*. This biological material was used for the preparation of the dishes studied, namely: « Tôh » of cassava with sauce based on *Byttneria catalpifolia* (TBC), « Tôh » of cassava with sauce based on *Beilschimidia mannii* (TBM), « tôh » of cassava with *Sesamum radiatum* sauce (TSR), rice with *Beilschimidia mannii* sauce (RBM) and rice with *Sesamum radiatum* sauce (RSR).

2.2 Methods

Traditional dishes were selected after a survey of 1065 households and during focus groups on the 24-hour recall and frequency of consumption during the P1 or post-harvest period (October to February) and the rainy period P2 (July to September). After cooking the different entities, the respective proportions of the carbohydrate food (400.8 to 650.4 g) and the sauce (400.4 to 501.25 g) were homogenised with a "German chef" electric mixer. The moisture content was determined from an aliquot sampled and then steamed at 105° C until a constant weight was obtained. The rest of the sample was kept for further analysis. The protein, moisture content was determined by the AOAC method (1990) [3]. Total carbohydrates by the method of Egan *et al.* (1981), lipids by the AFNOR method (1986), fatty acids by the NF ISO 6320 method (1978) and fibres by the Multon method (1991). Dry matter and ash were determined by the AOAC method (1990) [3]. Mineral elements other than phosphorus and iodine were determined by atomic absorption spectrophotometry according to the AOAC (1990) [3] digestion method. The determination of iodine in food was carried out according to the method of Mannar and Dunn (1995) [19]. The determination of phosphorus was carried out by the method of Taussky and Shorr (1953). The vitamin C content of the samples was determined according to the method described by Pougacz (1971) [21]. The SAIN score used is based on five nutrients: protein, fibre, vitamin C, calcium and iron. The LIM score is based on three nutrients: saturated fatty acids, sodium and added sugar. The results were analysed using IBM SPSS

Statistics 20 software, Statistica 7.1 and expressed as mean ± Standard Deviation.

3. Results

3.1 Biochemical composition

Moisture content was average and ranged from 67.4±0.2 (RBM) to 71.9±0.2 (TSR) g/100g in the post-harvest period and from 65.8±0.1 (TBM) to 71.1±0.3 (RSR) g/100g fresh material for the lean period. Protein content was average and ranged from 6±0.1 (TSR) to 8.7±0.1 (RBM) g/100g in the post-harvest period and from 3.2±0.2 (TBC) to 5.9±0.2 (RBM) g/100g in the lean period. There is a significant difference between the averages of the protein content of dishes from the post-harvest period (4.4±1.38 g/100g DM) and the lean period (7.2±1.2 g/100g DM) at the p=0.05 threshold. Lipid contents were low and varied in the post-harvest period from 2.1±0.2 (TBM) to 3.4±0.2 (RBM) g/100g and from 2.8±0.0 (TBM) to 4.6±0.2 (TBC) g/100g dry matter for the lean period. Total carbohydrates range from 14.9±0.1 (TBC) to 18.8±0.1 (RSR) g/100g for the post-harvest period and from 14.4±0.3 (RSR) to 23.1±0.1 (TBM) g/100g for the lean period. The dishes had a low crude fibre content ranging from 1.6±0.2 (TBC) to 3±0.0 (TSR) g/100g for the post-harvest period and from 1.6±0.1 (RSR) to 4.8±0.1 (TBC) g/100g dry matter for the lean period (Table 1).

3.2 Mineral composition

The contents are expressed per 100g of dry matter (DM). The results showed that the ash contents ranged from 1.7±0.1 (RBM) to 5.6±0.2 (TBC) g/100g DM. The dishes had very high levels of sodium (Na) ranging from 1124.7±0.1 (TBM) to 2367.8±0.1 (TBC) mg/100g DM. Potassium (K) levels were low and ranged from 114.6±0.0 (RBM) to 1583.9±0.1 (TBC) mg/100g DM. The dishes had high levels of phosphorus (P) ranging from 316.6±0.2 (RBM) to 922.6±0.1 (TBC) mg/100g DM. Calcium (Ca) levels were high and ranged from 299±0.1 (RBM) to 1593.7±0.1 (TBC) mg/100g DM. Iron (Fe) levels were also high and ranged from 5±0.1 (TBM) to 12±0.1 (TSR) mg/100g DM. Iodine levels were average and ranged from 9.8±0.2 (TSR) to 13.4±0.2 (TBC) µg/100g DM. Vitamin C (Vit C) levels ranged from 0.2±0.2 (RBM) to 3.2±0.2 (TBC) mg/kg of fresh material (Table 2).

Table 1: Biochemical composition of the different dishes

Dishes	Periods	Moisture	Protein	Lipids	Total Carbohydrates	Fibres
TBM	P1	71.3±0.1 ^e	6.1±0.2 ^b	2.1±0.2 ^a	16.7±0.2 ^b	2.8±0.1 ^{de}
	P2	65.8±0.1 ^a	3.4±0.3 ^a	2.8±0.0 ^b	23.2±0.1 ^g	2.1±0.1 ^{bc}
RBM	P1	67.4±0.2 ^c	8.7±0.1 ^e	3.4±0.2 ^c	18.1±0.2 ^{cd}	2.2±0.2 ^e
	P2	70.6±0.1 ^d	5.9±0.2 ^b	4.1±0.2 ^d	17.7±0.2 ^c	1.7±0.1 ^{ab}
TSR	P1	71.9±0.2 ^f	6±0.1 ^b	2.2±0.3 ^a	16.2±0.1 ^b	3±0.0 ^e
	P2	67.5±0.2 ^c	3.6±0.2 ^a	2.8±0.1 ^b	20.9±0.2 ^f	2.1±0.2 ^{bc}
RSR	P1	67.7±0.1 ^c	8.1±0.2 ^d	3.1±0.2 ^{bc}	18.9±0.0 ^d	2.4±0.1 ^{cd}
	P2	71.1±0.3 ^e	5.9±0.1 ^b	4.3±0.1 ^{de}	14.4±0.3 ^a	1.6±0.1 ^a
TBC	P1	70.4±0.1 ^d	6.9±0.3 ^c	3.3±0.1 ^c	15.1±0.1 ^a	1.6±0.2 ^a
	P2	66.6±0.2 ^b	3.2±0.2 ^a	4.6±0.2 ^e	19.9±0.2 ^e	4.8±0.1 ^f

On the same column, the figures followed by the same letter are not significantly different at the 5% threshold; TBC: « Tôh » of cassava with sauce based on *Byttneria catalpifolia*; TBM: « Tôh » of cassava with sauce based on *Beilschimidia mannii*; TSR : « Tôh » of cassava with sauce based on *Sesamum radiatum*; RBM : Rice with sauce based on *Beilschimidia mannii*; RSR : Rice with sauce based on *Sesamum radiatum*; P1 : Post-harvest period; P2 : Seasonal period.

Table 2: Content of some minerals and vitamin C in different dishes

Dishes		Ash (g/100g)	Minerals (mg/100g DM)					Vitamin (mg/kg)	
			Na	K	P	Ca	Fe	I (µg)	Vit C
RBM	P1	2.4±0.1 ^b	1490.7±0.2 ^g	114.6±0.0 ^a	550.8±0.1 ^d	368.2±0.0 ^b	7.3±0.2 ^c	13.1±0.2 ^{ef}	0.2±0.2 ^a
	P2	1.7±0.1 ^a	1398.5±0.1 ^e	125.5±0.1 ^b	316.6±0.2 ^a	299±0.1 ^a	6.4±0.1 ^b	12.6±0.1 ^d	0.3±0.0 ^a
TBM	P1	3.9±0.1 ^c	1124.7±0.1 ^a	1265.2±0.1 ^h	500.8±0.0 ^c	628.9±0.1 ^e	6.1±0.0 ^b	12.9±0.3 ^{de}	2.8±0.3 ^c
	P2	4.8±0.2 ^e	1275.6±0.2 ^b	1128.4±0.2 ^e	394.9±0.2 ^b	512.1±0.2 ^c	5±0.1 ^a	12.5±0.2 ^d	2.1±0.1 ^b
RSR	P1	2.2±0.2 ^b	1579.3±0.1 ^h	514.7±0.1 ^d	763.7±0.1 ⁱ	782.8±0.1 ^f	13.8±0.2 ^h	10.5±0.1 ^{bc}	0.4±0.1 ^a
	P2	4.3±0.2 ^d	1485.7±0.0 ^f	501.9±0.2 ^c	649.2±0.3 ^f	601±0.1 ^d	11.7±0.1 ^g	10.9±0.3 ^c	0.3±0.2 ^a
TSR	P1	3.8±0.1 ^c	1352±0.2 ^c	1543.3±0.1 ⁱ	714.6±0.0 ^g	999.2±0.2 ^h	12±0.1 ^g	9.8±0.2 ^a	3.1±0.1 ^{de}
	P2	5.1±0.1 ^e	1370.1±0.1 ^d	1247.8±0.0 ^f	599.3±0.2 ^e	868.1±0.0 ^g	10.3±0.3 ^e	10.1±0.2 ^{ab}	2.4±0.3 ^b
TBC	P1	4.4±0.1 ^d	2250.2±0.2 ⁱ	1583.9±0.1 ^j	922.6±0.1 ^j	1227.5±0.2 ⁱ	9.8±0.2 ^d	13.4±0.2 ^f	3.2±0.2 ^e
	P2	5.6±0.2 ^f	2367.8±0.1 ^j	1251.2±0.2 ^g	760±0.1 ^h	1593.7±0.1 ^j	11.1±0.2 ^f	13.2±0.1 ^{ef}	2.9±0.2 ^{cd}

On the same column, the figures followed by the same letter are not significantly different at the 5% threshold; TBC: « Tôh » of cassava with sauce based on *Byttneria catalpifolia*; TBM: « Tôh » of cassava with sauce based on *Beilschimidia manni*; TSR : « Tôh » of cassava with sauce based on *Sesamum radiatum*; RBM : Rice with sauce based on *Beilschimidia manni*; RSR : Rice with sauce based on *Sesamum radiatum*; P1 : Post-harvest period; P2 : Seasonal period.

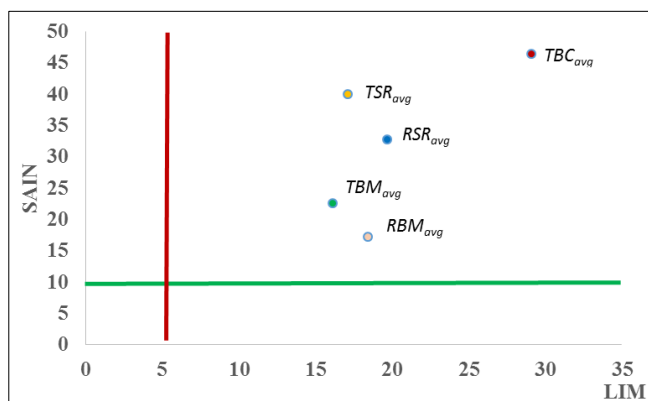
3.3 Nutritional profile of dishes

The results showed that the SAIN and LIM scores varied for each dish according to the period. SAIN scores ranged from 16 to 42 and LIM scores from 15 to 30. The average SAIN scores ranged from 17.2 to 46.3 and the average LIM scores from 16.2 to 29.1 (Table 3).

Table 3: Average SAIN and LIM scores of the different dishes

Dishes	SAIN avg.	LIM avg.
TBM	22.5	16.2
RBM	17.2	18.5
TSR	40	17.1
RSR	32.8	19.7
TBC	46.3	29.1

All dishes are located in quadrant 3, i.e. high SAIN and LIM scores. Dishes based on *Beilschimidia manni* sauce have a low SAIN score compared to dishes based on *Sesamum Radiatum* and *Byttneria catalpifolia* sauce. The results showed that dishes with *Byttneria catalpifolia* sauce had the highest LIM scores. The average SAIN and LIM scores (average of the two periods) of the dishes showed that the TBC dish has the highest SAIN and LIM scores. The dish TBM had the lowest LIM score and the dish RBM the lowest SAIN score (Figure 1).

**Fig 1:** Average SAIN and LIM profile of dishes

4. Discussion

The water content of the dishes was average (65.8 to 71.9 g/100g of fresh matter) and would be due to the viscous state and consistency of the sauces desired by the cooker. These water contents were lower than those found by Kana

et al. (2008a), which ranged from 70.13 to 88.93 g/100g of fresh matter (F.M.) in the dishes consumed in Douala (Cameroon) and slightly higher than those found by Ponka *et al.* (2005b) [22], which ranged from 49.5 to 67.9 g/100g F.M in the dishes consumed in West Cameroon. The ash content provides an indication of the mineral content of the dishes. Our results showed that the ash contents of the meals (1.7 - 5.6 g/100g DM) were average. They are higher than those of Ponka *et al.* (2016) [23] in the Cameroonian dishes which ranged from 1 to 1.7 g/100g dry matter (DM) and lower than those of Kana *et al.* (2008b) (3.6 to 7.82 g/100g DM). The protein content (3.2 to 8.7 g/100g DM) of the dishes was average and would be justified by the use of fish (fresh or dry) which is a basic ingredient in all these dishes. These protein levels were lower than those found by Fokou *et al.* (2009) [10] which ranged from 1.93 to 32.93 g/100g D.M., and those found by Kana *et al.* (2008a) ranging from 9.25 to 16.86 g/100g D.M. Proteins are important to the body because they are found in all tissues and serve as the basis for enzymes, hormones, neurotransmitters and antibodies (Anses, 2019). The average protein content of dishes in the post-harvest period P1 (7.3 g/100g D.M) is significantly different from that in period P2 (4.4 g/100g D.M) because in period P1, the consumption of proteins of animal origin increases due to the availability of financial resources from the sale of agricultural products (food and/or perennial crops).

Dietary fibre is important in the human diet because it facilitates intestinal transit, reduces serum cholesterol and hypertension (Anhwange *et al.*, 2004; Hassan and Umar, 2004). The crude fibre contents (1.6 to 4.8 g/100g DM) of the dishes were average. These levels were lower than those determined by Kana *et al.* (2008a) (5.57 to 38.8 g/100g D.M) and higher than those determined by Ponka *et al.* (2005b) [22] (0.84 to 3.18g/100g DM). These dishes are a good source of fibre because, according to the DGA (2005), fibre intake limits must vary from 1.4% to 3.5%.

The lipid contents (2.1 to 4.6 g/100g DM) of the dishes were low. These lipid contents are lower than those of Ponka *et al.* (2005b) [22] (7.79 to 17.6 g/100 g M.S) and Kana *et al.* (2008a) (10.64±0.9 to 35.72±8.56 g/100 g DM). An increase in nutrient intakes of Polyunsaturated Fatty Acids (PUFA) and a PUFA/SFA (Saturated fatty acids) ratio of about 1 (one) leads to a significant decrease in blood pressure, in favour of a reduction in the risk of cardiovascular disease (Hall, 2009; Lacono *et al.*, 1982) [11, 18]. The low PUFA/SFA

ratio (0.2 to 0.3) of the food would expose consumers to the occurrence of high blood pressure.

The total carbohydrate contents of the dishes, which ranged from 15.1 to 23.2 g/100g (DM), were low. Most of these carbohydrates would come from the carbohydrate food (rice or « Tôh » of cassava). These carbohydrate levels were lower than those found by Kana *et al.* (2008a) (24.11±9.21 to 62.05±3.02 g/100g DM) and Fokou *et al.* (2009)^[10] (4.79 to 69.75 g/100g DM). Calcium levels ranging from 299 to 1593.7 mg/100g DM were very high compared to those obtained by Ponka *et al.* (2016)^[23] (13.4 to 38.9 mg/100g DM) and Kana *et al.* (2008b) (32 to 878.33 mg/100g DM). Most of the calcium comes from the various ingredients of plant origin used during preparation. Potassium levels were low, ranging from 114.6 to 1583.9 mg/100g DM. These results were corroborated by those of Kana *et al.* (2008b) (197.33 to 1346.33 mg/100g DM) in Cameroonian dishes and Bthissam (2014)^[5] (681 to 1483 mg/100g DM) in Tunisian dishes. Potassium intake in the diet (3500 mg/day) lowers blood pressure and protects against strokes and cardiac arrhythmias (EFSA, 2016)^[9].

The iron levels obtained in the dishes were high and ranged from 5 to 12 mg/100g DM. These results were corroborated by those found by Bthissam (2014)^[5] (3.25 - 29.35 mg/100g DM) and higher than those obtained by Ponka *et al.* (2016)^[23] (0.5 - 1.5 mg/100g DM). This result could be justified by the fact that the main ingredients are plant organs (dry leaves, dried almonds) rich in iron. Phosphorus is a component of bones and teeth and the recommended dietary intake is 700 to 1200 mg/day depending on age (IOM, 2006)^[14]. The phosphorus levels obtained in the dishes were high (316.6 - 922.6 mg/100g DM). They were higher than those obtained by Kana *et al.* (2008b) which ranged from 58.67 to 616.33 mg/100g DM. Sodium plays an important role in the distribution of water in the body and influences blood pressure, the transmission of nerve impulses and muscle contraction. The maximum recommended intake for adults is 2 grams per day (WHO, 2013)^[25]. Sodium levels were high (1124.7 to 2367.8 mg/100g DM) because housewives used large quantities of cooking salt when making sauces, hence the very salty taste of the sauces. These sodium levels were much higher than those obtained by Bthissam (2014)^[5] (444 - 904 mg/100g DM) and Ponka *et al.* (2016)^[23] (336.2 - 567.9 mg/100g DM). The iodine content of the various dishes was high (9.8 to 13.4 µg/100g) and is thought to be due to the use of large amounts of iodised salt during preparation. These iodine levels are higher than those obtained by Kouamé *et al.* (1998)^[17], which ranged from 0.13 to 7.5 µg/kg. All dishes are classified as foods to be eaten occasionally or in small quantities. They all have SAIN scores above the threshold value of 5, so here it is the LIM score that is lacking, that is to say the intake of sodium and saturated fatty acids. Our results are corroborated by those of Bthissam (2014)^[5] who showed that the Tunisian dishes were all housed within the framework of food to be consumed from time to time or in small quantities and the incriminated ingredients that lowered the nutritional quality of these dishes were oil and salt.

5. Conclusion

Most of the ingredients used in the preparation of the various dishes come from biodiversity and are available all year round. Regardless of the time of year, these dishes are good sources of nutrients (SAIN>5). These traditional

dishes are to be eaten in small quantities or occasionally (LIM>7.5) and the offending nutrients are sodium and saturated fatty acids. In the post-harvest period, the nutritional quality of the dishes is significantly improved, especially in terms of protein content.

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