International Journal of Innovation Engineering and Science Research
(ISSN: 2581-4591)
www.ijiesr.com

Valorization of *Moringaoleifera* leaves by incorporation in tamarin (*Tamarindusindica*) and banana (*Musa sativa*) pastes

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ABSTRACT

This study concerns the valuation of *Moringaoleifera* leaves which come from 2 regions of Madagascar: Antananarivo and Tulear. A survey carried out showed that only 42.5% of the people questioned declared to have already consumed *Moringaoleifera* leaves and that they were consumed occasionally, that is to say 81% of the respondents. Those who have already consumed it do not adopt the good culinary methods since 40% and 25% consume it in decoction and soup and only 25% in salad. Thus, the incorporation of *Moringaoleifera* leaves in tamarind *(Tamarindusindica)* and banana *(Musa sativa)* pastes was undertaken. Nutritional analysis showed that the energy value of Tulear leaves is higher than that of Antananarivo, respectively 375.53Kcal and 323.86Kcal per 100g of leaf powder. In addition, the protein and lipid contents are higher in Moringa leaves from Tulear than those from Antananarivo, that is 19.6%, 3.01% against 18.2% and 2.18%. In contrast, the mineral content was higher in Moringa leaves from Antananarivo (11.76%) than those from Tulear (8.00%). Moringa Banana and tamarind pasta was the subject of a sensory analysis which showed that Moringatamarin pasta (hedonic average of 6.470 and 5.930) was more popular than Moringa banana paste (hedonic average of 5.230 and 5.930).

Keywords: *Moringaoleifera*, tamarind paste, banana paste, nutritional analysis, sensory analysis.

I. INTRODUCTION

Madagascar is privileged by the diversity of food plants due to its geographical and climatic situation. Tropical and semi-tropical fruits such as bananas, mangoes, apples, oranges, melons...; vegetables, mainly carrots, beans, green beans, cucumbers; also leafy vegetables such as chard, leeks, cabbage and many others are the most sold and bought in the markets. Despite this diversity of its resources, There is chronic malnutrition in Madagascar, which affects 47% of children under the age of 5 [8], which has consequences for the cognitive and physical development of the child as it affects learning capacity, productivity in adulthood and therefore the country's economy [8].

The daily energy intake of 2133 kcal/per capita/day is not reached [3]. In fact, households have poor food consumption in terms of quantity and quality, respectively 60% and 58% of households [2], [7]. The causes of malnutrition are diverse, including inappropriate eating habits, economic crises, lower incomes and limited access to raw materials. To avoid this food insecurity, other edible and available natural resources have been highlighted, *Moringaoleifera* called “the tree of many uses» [4].

Thus, in this study, tamarin and banana pastes are used as snacks at any time of the day, enriched at 30% with powdered *Moringaoleifera* leaves [5] from Tulear and Antananarivo. The objective is to valorize available and edible food resources that are not usually consumed and to contribute to the fight against chronic malnutrition.

II. MATERIALS AND METHODS

II.1. Material

The study materials are *Moringaoleifera* leaves collected in Tulear and Antananarivo. They were transported without being removed from their stems. During the study, the leaves from the two localities were processed separately. Then, the fruits, bananas (*Musa sativa*) and tamarind (*Tamarindusindica*) bought at the market of Anosy be.

Tamarind and banana pastes are enriched with 30% of Moringa leaf powders from Antananarivo and Tulear according to the method described by HARIMALALA ANDRIAMBELO, 2014.

The results are processed in Excel.

II.2.2. Determination of the nutritional composition of *Moringaoleifera* leaves from Tulear and Antananarivo [1].

The pH of the samples is measured with a pH meter (type TACUSSEL) on a 20% sample solution in distilled water

The water content is determined according to the Guilbot methodby drying the samples in a ventilated oven until a constant weight is obtained with a precision of ±0.001.

The lipid content is obtained by the Soxhlet method: fats are extracted with petroleum ether by reflux system for seven hours.

The amount of ash is determined by calcining the sample in a muffle furnace for 16 hours at 600°C. The amount of mineral elements (sodium, potassium and magnesium) is measured from the ash with an atomic absorption spectrophotometer.

The crude protein was determined using micro Kjeldahl method as described in AOAC procedures (AOAC, 2000).

The carbohydrate content of a food can be determined by calculating the percent remaining after all the other components have been measured: % Carbohydrates = 100 - %Moisture - %Protein - %Lipid - %Mineral.

The energy content of each plant samples were determined by multiplying the values obtained for protein, fat and available carbohydrate by 4.00, 9.00 and 4.00, respectively and adding up the values, according to Atwater index (AOAC, 2000).

II.2.3. Determination of consumers' appreciation of products[6]

The hedonic test is used to determine consumers preference for products and to deduce their acceptability. The evaluation is done in order to know which of the fruit pastes, banana and tamarind, enriched with *Moringaoleifera* leaves from Tulear or Antananarivo is the most appreciated. To do this, the samples are presented anonymously, the subject must give his appreciation on a rating scale of 1 to 9 by filling out an individual form.

The statistical processing is carried out with the XLSTAT 2014 software with a significance level of 0.05.

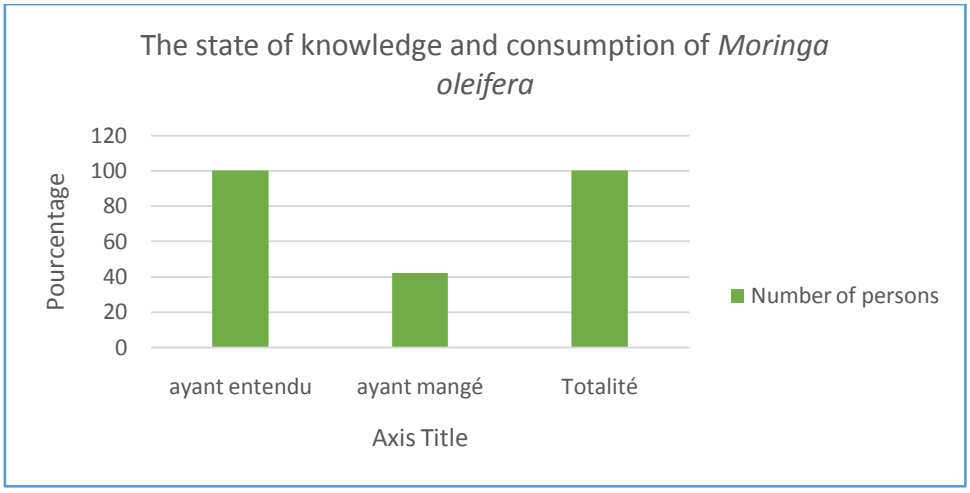

Figure 1 :State of knowledge and consumption of Moringaoleifera

Thus, respondents claim to have heard of the nutritional and therapeutic properties of *Moringaoleifera*, but only 42.5% have ever consumed it at least once.

Figure 2 shows that among those who had ever consumed *Moringaoleifera* leaves, the majority consumed it occasionally, i.e. 81%. Figure 3 shows that 69% of respondents buy Moringa leaves at the market, 14% do not buy but have a plant at home, and 17% choose or ask someone they know.

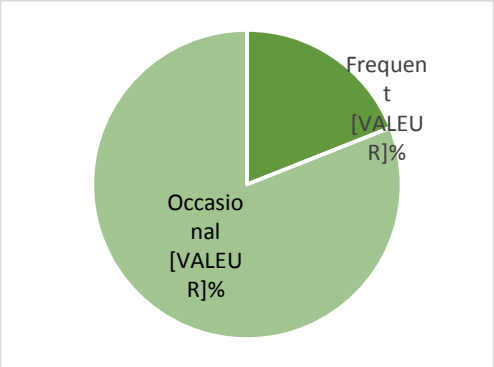

Figure 2 : Frequency of consumption of Moringa

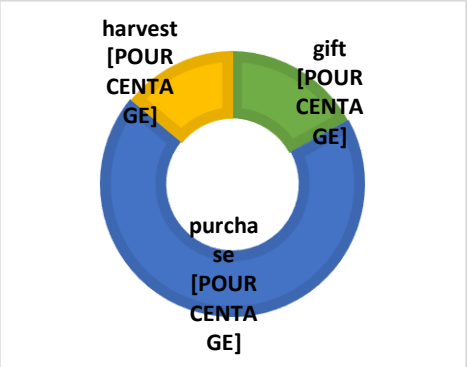

Figure 3: Means of obtaining Moringa

Dried leaf powder of *Moringaoleifera* is one of the most effective ways of preservation (DE SAINT SAUVEUR and Coll., 2010). According to surveys, 62% of respondents say they like the taste of the leaves, while 30% are reluctant because of its rather strong aroma (ANDRIAMITAHA, 2016). This method of preservation is not known by the Malagasy who consume it fresh. Thus, Figure 4 illustrates the modes of consumption of the leaves.

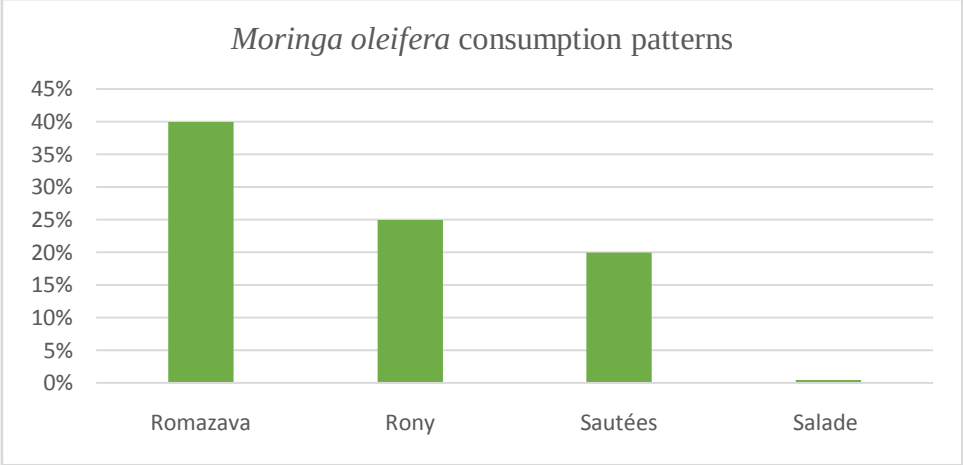

Figure 4: Methods of preparation of Moringa leaves

Moringa leaves are most consumed as a "romazava" (décoction), i.e., more than 40% of respondents, or in soup with meat, i.e., about 25% of respondents. Very few know about its consumption in salads.

III.2 Results of nutritional analyses of Moringa leaves from Tulear and Antananarivo.

Table 1 shows the nutritional values of Moringa leaves from Antananarivo and Tulear.

Table1 : Nutritional composition of Moringaoleifera leaf powders (in g per 100g sample) from Antananarivo and Tulear

	Antananarivo	**Tuléar**
Matière sèche	90	98,12
Eau	10	1,88
Protéines	18,2	19,6
Lipides	2,18	3,01
Glucides	57,86	67,51
Cendres brutes	11,76	8,0
Fibres	1,6	1,9
Valeur énergétique (Kcal)	323,86	375,53

The results obtained show that Moringa leaves from Antananarivo have a higher water content (10%) than those from Tulear (less than 2%). This low water content of the Tulear leaf powders gives it a high dry matter content of 98%.

The protein contents are respectively 18.2% and 19.6% for the leaf powders from Antananarivo and Tulear. However, the Antananarivo leaf powder is lower in protein than that from Tulear.

The crude ash content of the Moringa leaf powders was high, at 11% and 8% for Antananarivo and Tulear respectively, indicating a high mineral content. However, the leaves from Tuléar are less rich in mineral elements than those from Antananarivo.

In terms of energy, the *Moringaoleifera* leaf powders have a high energy density, with the Tulear leaf powder providing more energy than the Antananarivo leaf powder.

Table 2 gives the frontal references and the amino acid composition of the samples.

Table2: Amino acid composition of Moringaoleifera

Acides aminés	Références frontales	Moringa Antananarivo	Moringa Tuléar
Histidine	0,20	-	His
Méthionine	0,62	Met	Met
Acide aspartique	0,17	-	Asn
Isoleucine	0,74	Ile	Ile
Tyrosine	0,47	Tyr	-
Glutamine	0,31	Glu	Glu
Alanine	0,38	Ala	-
AA1	0,11	-	AA1
AA2	0,08	-	AA2
AA3	0,03	-	AA3

The results in Table 2 show the qualitative presence of 5 identifiable amino acids including the essential amino acids: methionine, isoleucine and essential in children which is histidine. Referring to the chromatogram, Moringa from Tulear is composed of 3 amino acids more than that of Antananarivo.

III.3. Sensory analysis results

The hedonic test is carried out on banana and tamarind pastes enriched with Moringa leaf powder enriched with 30% *Moringaoleifera* from Antananarivo and Tulear. The test is carried out on 113 naive consumers, over the age of 15. Table 3 gives the means of the hedonic values of the products.

Table3: Average hedonic values of banana and tamarind pastes enriched with Moringa

Produits	PB Tana	PB Tulear	PT Tana	PT Tulear
Moyennes	5,23	5,93	6,2	6,47

The results show hedonic values for all four products that are higher than 5, indicating that all four types of enriched pastes are appreciated by consumers. However, tamarind pastes enriched with Moringa leaves from Tulear are more appreciated since the hedonic values are higher than those of tamarind pastes enriched with Moringa from Antananarivo. This assessment is confirmed by the sum of the rankings of consumer preference of the products in Table 4.

Table4: Sum of preference rankings for banana and tamarind pastes with Moringa leaf powder

Produits	PB Tana	PB Tuléar	PT Tana	PT Tuléar
Somme des rangs	339	284	267	240

The results show that the smaller the sum of the ranks, the more the product is appreciated. Thus, in ascending order, consumer preference for the different fruit pastes is as follows: Tamarind pastes from Tulear> Tamarind pastes from Antananarivo > Banana pastes from Tulear> Banana pastes from Antananarivo.

A multiple comparison test and a product clustering test are performed to identify significant differences between products. The results are reported in Tables 5 and 6.

Tableau 5: Multiple comparaison test of Moringaoleifera fruit pastes from Antananarivo and Tulear

Modailtés	différence	différence réduite	valeur critique	Pr.>Diff	Significatif
PB Tana~PT Tuléar	-1,24	-1	12,706	0,5	Non
PB Tana~PT Tana	-0,97	-0,782	12,706	0,577	Non
PB Tana~PB Tuléar	-0,7	-0,565	12,706	0,673	Non

PB Tuléar ~PT Tuléar	-0,54	-0,435	12,706	0,739	Non
PB Tuléar ~PT Tana	-0,27	-0,218	12,706	0,864	Non
PT Tana~PT Tuléar	-0,27	-0,218	12,706	0,864	Non

Tableau 6 Product classification and grouping test

Modalités	Moyenne valeur hédonique	Regroupements
PB Tana	5,23	A
PB Tuléar	5,93	A
PT Tana	6,2	A
PT Tuléar	6,47	A

Thus, the statistical results of the test show that there is no significant difference in consumer appreciation and acceptability between tamarind and banana pastes made with Moringa leaf powder from Antananarivo and Tulear.

IV. DISCUSSION

Tamarind and banana pastes enriched with *Moringaoleifera* from Antananarivo and Tulear are products that allow, on the one hand, to valorize foods that are placed in the background of the diet such as *Moringaoleifera* and *Tamarindusindica*. On the other hand, these products are rich in protein and mineral elements provided by the leaves of *Moringaoleifera* and whose analysis of products has been done in previous works [5]. They contribute to the achievement of the recommended nutritional intake [3] of the population. These products allow diversification of food intake, especially snacks made from natural raw materials, and contribute to protein and mineral intake. They are also a means to alleviate household food insecurity and to contribute to the fight against malnutrition.

V. CONCLUSION

In order to fight against chronic malnutrition, which is the most serious form of malnutrition, it is interesting to enhance the value of existing food products in the various localities and to proceed with enrichment in order to provide the daily needs necessary for the organism and to allow for food diversification.

REFERENCES

[1] AFNOR, Contrôle de la qualité des produits alimentaires, les méthodes d'analyses officielles. Paris : AFNOR, 1ère édition, 1989. 373p.

[2] AGSANV, 2013. Analyse Globale de la Sécurité Alimentaire et Nutritionnelle, et de la Vulnérabilité (AGSANV), Résumé. 11p.

[3] FAOSTAT, 2014. Données de l'alimentation et de l'agriculture.

[4] HALDAR R., KOSANKAR S. 2017. *Moringaoleifera* :l'arbre miracle. International Journal of Advance Research Ideas and Innovation in Technology. ISSN : 2454- 132x. Vol 3, Issue 6. 2017.

[5] HARIMALALA ANDRIAMBELO N., 2014. Nutritional quality of fruit pastes enriched with *Moringaoleifera* leaves. In International Journal of Applied Science and Technology. SSN 2221-0997 (Print), 2221-1004 (Online). Vol 4, N°5, 2014.

[6] LEFEBVRE A., BASSEREAU J. 2003. L'analyse sensorielle, une méthode de mesure au service des acteurs de la conception : ses avantages, ses limites, ses voies d'amélioration. pp3-11.

[7] PAM 2014. Analyse Globale de la Sécurité Alimentaire et Nutritionnelle, et de la Vulnérabilité, Madagascar. Programme Alimentaire Mondial, Service de l'Analyse de la Sécurité Alimentaire (VAM)

[8] PNAN III, 2017- 2021. Plan National d'Action pour la Nutrition. La nutrition garant d'un capital humain pour un développement social et économique durable. 46 p.