

Research Application Summary

**Effectiveness of *Cochlospermum tinctorium* root powder based sauce fortified with moringa leaf powder in improving nutritional status of children aged 6 to 59 months in Northern Benin**

Agossadou, J.O.<sup>1,2</sup>, Houndji, B.V.S.<sup>2</sup>, Somessi, A.B.<sup>2</sup>, Nago, E.S.H.<sup>2</sup> & Chadare, F.J.<sup>1,3</sup>

<sup>1</sup>Laboratory of Food Science, Faculty of Agronomic Science, University of Abomey-Calavi, BP 526, Abomey- Calavi, Contonou, Benin

<sup>2</sup>Ecole de Nutrition, Sciences et Technologies Alimentaires, Faculty of Agronomic Science, University of Abomey-Calavi, BP 526 Abomey-Calavi 229 Atlantique, Benin

<sup>3</sup>Ecole des Sciences et Techniques de Conservation et de Transformation des Produits Agricoles, Université Nationale d'Agriculture

**Corresponding author:** fchadare@gmail.com

---

**Abstract**

Inappropriate complementary feeding is a major cause of malnutrition in young children in developing countries. The present study aimed at testing the effect of the consumption of *Cochlospermum tinctorium* root powder (CTRP) based sauce fortified with moringa leaf powder on the nutritional status of children aged 6 to 59 months in northern Benin. A two-week intervention in the form of nutrition rehabilitation hub was implemented in Tanguieta (Benin) among children suffering from moderate or mild acute malnutrition. A sample of 64 children aged 6-59 months was randomly selected and assigned to an intervention group and a control group. The 31 children in the intervention group consumed 100 g of CTRP based sauce fortified 10 g of moringa leaf powder daily for two weeks in the nutritional rehabilitation hub whereas the 33 in the control group kept their habitual diet and ate common foods from the study area. The nutritional status of the children were assessed using anthropometric parameters (weight, height) and age. Results from the study showed that the daily consumption of the food formula for two weeks significantly ( $p<0.05$ ) improved children weight at the end of the trial. In addition, the children recovery rate and the acceptability rate of the sauce were respectively 82% and 80 % in the intervention group. It can be concluded that CTRP based sauce fortified with moringa leaf powder may contribute to fight against child malnutrition in Benin.

**Key words:** Benin, children, *Cochlospermum tinctorium*, malnutrition, moringa leaf powder, nutritional rehabilitation, nutritional status, recovery rate

**Résumé**

Une alimentation complémentaire inappropriée est une cause majeure de malnutrition chez les jeunes enfants dans les pays en voie de développement. La présente étude visait à tester l'effet de la consommation des sauces à base de poudre de racine de *Cochlospermum tinctorium* (CTRP) enrichie avec la poudre de feuilles de moringa, sur l'état nutritionnel des enfants âgés de 6 à 59 mois dans le nord du Bénin. Une intervention de deux semaines sous forme de foyer de rééducation nutritionnelle a été faite à Tanguieta (Bénin) auprès des enfants souffrant de malnutrition aiguë

modérée ou légère. Un échantillon de 64 enfants âgés de 6 à 59 mois a été sélectionné au hasard et attribué à un groupe d'intervention et à un groupe témoin. Les 31 enfants du groupe d'intervention ont consommé quotidiennement 100 g de sauce à base de CTRP enrichie de 10 g de poudre de feuilles de moringa dans le foyer de rééducation nutritionnelle, tandis que les 33 enfants du groupe témoin ont conservé leur régime alimentaire habituel et ont mangé des aliments courants de la zone d'étude. L'état nutritionnel des enfants a été évalué à l'aide de paramètres anthropométriques (poids, taille) et l'âge. Les résultats de l'étude ont montré que la consommation quotidienne de la formule alimentaire pendant deux semaines augmentait considérablement ( $p < 0,05$ ) le poids des enfants à la fin de l'essai. De plus, le taux de récupération chez les enfants et le taux d'acceptabilité de la sauce étaient respectivement de 82% et 80% dans le groupe d'intervention. On peut donc conclure que les sauces à base de poudre de racine de *Cochlospermum tinctorium*, enrichie avec la poudre de feuilles de moringa, peuvent contribuer à lutter contre la malnutrition infantile au Bénin.

Mots clés: Intervention, malnutrition, foyer de réhabilitation nutritionnelle, état nutritionnel, taux de récupération

---

## Introduction

*Cochlospermum tinctorium*, a plant of widespread occurrence in the savannah and scrub land throughout the drier parts of the West African Region is reported to be used as traditional medicine in Côte d'Ivoire, Ghana, Cameroon, Nigeria, Gambia, Guinea, Senegal and Burkina Faso (Nergard *et al.*, 2004). According to Ayosso (2016), *Cochlospermum tinctorium* root powder is rich in zinc and iron. This micronutrients rich plant root powder is commonly consumed as vegetable by children in the north of Benin (Affonfere, 2018). However, the notion that complementary foods fed to children aged 6–24 months, particularly in developing countries, are plant-based and are not efficient to meet nutrient needs at this age is reported by Waswa *et al.* (2015). According to Egyir *et al.* (2016), animal protein based foods such as meat and milk were often kept for special occasions or provided to adult male household members because most mothers could not afford to buy them. Therefore, the fortification of the *Cochlospermum tinctorium* Root Powder (CTRP) based sauce with moringa leaf powder which is available and accessible in rural areas may be an alternative solution to reduce the problem of children malnutrition. Indeed, The World Health Organization (WHO) has promoted moringa tree as an alternative to imported food supplies to treat malnutrition (Salem *et al.*, 2013). Moreover, Abioye and Aka (2015) highlighted that moringa leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, more potassium than bananas, and the protein quality of moringa leaves is comparable to that of milk and eggs. The overall objective of this study was to test the effect of the consumption of a scientifically designed *Cochlospermum tinctorium* based sauce fortified with moringa leaf powder on the nutritional status of children aged 6 to 59 months in northern Benin.

## Methodology

**Experimental design and children selection.** The study was designed as a two arm randomized controlled trial among children aged 6 to 59 months with moderate and mild acute malnutrition in two villages of municipality of Tanguiéta (northern Benin). Villages were assigned randomly to an intervention village and a control village. The intervention group (31 children) consumed daily the fortified sauce in the nutritional rehabilitation hub during two weeks whereas the control group (33 children) consumed common foods from the study area. Indeed, exhaustive census of

children in the defined age range living in the study area was performed in the two different villages (intervention and control). Their anthropometric measurements such as weight and height were taken using stadiometer and scale. The age was recorded from the children birth certificates. The anthropometric index Z-score weight for height (WHZ)  $<-2$ ET that reflects the acute malnutrition were calculated using the software WHO Anthro. Only children with moderate ( $-3 <Z\text{-score} <-2$ ) or mild acute malnutrition ( $-2 <Z\text{-score} <-1$ ), who were not sick, or not under a medical treatment that could influence their nutritional status, were included in the study. With informed parental consent, 64 children completed the study.

**Determination of nutritional composition of the fortified sauce.** The intervention sauce was formulated in a laboratory taking into account children daily nutritional needs and acceptability of the sauce. Thus the micronutrients content of this sauce were measured in laboratory as outlined by Affonfere (2018) whereas the protein content was theoretically estimated according to Amabye (2016).

**Intervention.** In the case of a village, the chief's house was used for the nutritional rehabilitation hub. Eligible children's mothers brought their children every morning to the hub where they consumed the fortified sauce with cereals (maize and rice) based foods for two weeks. The anthropometric measurements in both groups were performed at baseline and endline. Children's mothers were those who cook the sauce in the way they use to do it in this area. Cooked sauce was allowed few minutes to cool down and the moringa leaf powder was added. An amount of 100 g of CTRP based sauce was fortified with 10 g of moringa leaf powder.

**Ethical consideration.** The research study was approved by the "National Ethical Committee for Research on Health" of Benin N° 33 /MS/DC/SGM/DRFMT/CNERS/SA. In addition, children in the control group received as compensation an amount of the moringa leaf powder at the end of the intervention.

**Data management and statistical analysis.** The nutritional status of children was diagnosed at the end of the study using the software WHO Anthro. The t-student test was also performed to find out the difference between the two groups at baseline and endline in terms of weight, height and age.

## Results

**Nutritional quality of *Cochlospermum tinctorium* root powder based sauce fortified with moringa leaf powder.** Table 1 shows that the fortified sauce can cover 138.73-158.66 %, 288.40-663.33 %, 72.5-116 %, 134.68-215.5 % of respectively protein, iron, zinc and calcium estimated average requirement for children aged 6 to 59 months. Indeed the Estimated Average Requirements may be achieved if children consume daily the food formula assuming that the whole content is used by the body; it is probably lower.

**Effect of the intervention on the nutritional status of children.** Results obtained from the intervention pointed out that there was no significant difference between the intervention group and control group at baseline in terms of children weight, height and age ( $p > 0.05$ ). However, children's weight was significantly improved in the intervention group at endline (T-Value = -2,637; P-Value = 0,014; DF = 1). The recovery rate obtained at the end of the trial was 82 %.

**Acceptability of the fortified sauce.** Twenty per cent of children were not able to consume the fortified sauce every day for two weeks because of the taste and smell of moringa leaf powder

**Table 1. Nutritional value of fortified *Cochlospermum tinctorium* root powder sauce and infants under five years estimated average requirements**

Estimated average requirements	Protein	Iron	Zinc	Calcium
Children (6-12 months)	NA	6.9 (mg/d)	2.5 (mg/d)	NA
Children (12-36 months)	7.72 (g/d)	3 (mg/d)	2.5 (mg/d)	500 (mg/d)
Children (36-59 months) Nutritional value	6.75 (g/d)	4.1 (mg/d)	4 (mg/d)	800 (mg/d)
100 of <i>Cochlospermum tinctorium</i> based sauce fortified + 10 g of moringa leaf powder Cover rate (%)	10.71 ±0.81 g	19.9±0.5	2.9±0.4	1077.5±25.7
100 of <i>Cochlospermum tinctorium</i> based sauce fortified + 10 g of moringa leaf powder for children aged 6 – 59 months	138.73-158.66	288.40-663.33	72.5-116	134.68-215.5

Source: Affonfere (2018); Amabye (2016). NA : Non applicable

## Discussion

The consumption of the CTRP based sauce fortified with moringa leaf powder by children for two weeks improved significantly their weight. This is confirmed by Houndji *et al.* (2013) who found similar results after the daily supplementation of moringa leaf powder for six months. Note that protein and micronutrients (iron, zinc, calcium) contents of the fortified sauce used in the present study are in agreement with the Estimated Average Requirements of children aged 6 to 59 months. According to Steyn *et al.* (2001), wild plants are generally good sources of micronutrients. Indeed the fortified sauce can cover 138.73-158.66 %, 288.40-663.33 %, 72.5-116 %, 134.68-215.5 % of respectively protein, iron, zinc and calcium Estimated average requirement for children aged 6 to 59 months. Therefore, this sauce can be considered as balanced food for children in this age range as the sauce was consumed with cereal based foods. However, high nutrient content does not mean much if bioavailability is low (Hambidge, 2010; Schonfeldt *et al.*, 2016). As reported by Hemalatha *et al.* (2007), the bioavailability of micronutrients, particularly zinc and iron is low from plant foods. Ndong *et al.* (2007) highlighted that the iron in moringa leaf is not totally available and therefore the food fortified with this powder affects the iron bioavailability. Indeed Affonfere (2018) found that in vitro solubility of iron in the fortified sauce was 17.8±0.2 %. This fortified sauce need to be further studied to improve the iron in vitro solubility. According to Tontisirin *et al.* (2002), the low bioavailability of some key micronutrients from foods, such as Fe, is substantially enhanced with the right food combinations and with appropriate food processing and preparation techniques.

Furthermore, 20 % of children were not able to eat this sauce every day for two weeks due to the taste and smell of moringa leaf powder. In fact people commonly consume the moringa leaf as vegetable in this area. In addition the diversification of foods (maize and rice based foods) that is consumed with the sauce also probably help obtaining this rate of acceptability. However, in the study of Zongo *et al.* (2013), only 3.84 % of children vomited, had diarrhea, showed resistance to their first bowls of porridge mixed with moringa leaf powder during the first week because the use of moringa imparted

green coloration to the products making them appear greenish. The composition of the staple food and the amount of fortified food taken during the day by children are not mentioned in Zongo *et al.* (2016). Thus, the staple food used by Zongo *et al.* (2016) could be more compatible with moringa leaf powder in terms of color and taste than the one used in the present study. While the recovery rate should be > 75 % with an average length of stay of four weeks to conclude an adequate treatment DSME (2011), 82 % of children recovered in the present study within two weeks.

## Conclusion

The daily consumption of the *Cochlospermum tinctorium* based sauce fortified with moringa leaf powder for two weeks improved significantly the children weight at end of the trial. An acceptable recovery rate was obtained. Therefore, *Cochlospermum tinctorium* based sauce fortified with moringa leaf powder may contribute to the fight children malnutrition in Benin. The findings from the present study suggest: (i) a need for further studies are needed on the fortified sauce in order to improve the iron in vitro solubility and to make this sauce more acceptable by children, and (ii) promotion of the *Cochlospermum tinctorium* based sauce fortified with moringa leaf powder in Benin to fight against children malnutrition.

## Acknowledgement

This research was funded by the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) through grant N°RU 2015 GRG-125. This paper is a contribution to the Sixth African Higher Education Week and RUFORUM 2018 Biennial Conference.

## References

- Abioye, V.F. and Aka, M. O. 2015. Proximate composition and sensory properties of moringa fortified maize-Ogi. *J Nutr Food Sci* S12: 1-4.
- Affonfere, M. 2018. Formulation of infant foods fortified with baobab (*Adansonia digitata*) fruit pulp and/or moringa (*Moringa oleifera*) leaf powder for under-five-years old children in Benin University of Abomey-Calavi, Faculty of Agronomic Science. 194 pp.
- Amabye, T.G. 2016. Chemical compositions and nutritional value of *Moringa oleifera* available in the market of Mekelle. *Journal of Food and Nutrition Sciences* 3: 187-190.
- Ayosso, J.O.G. 2016. Diversité et valeur nutritionnelle des ressources alimentaires locales pour l'alimentation des enfants de 6 - 24 mois. FSA/EPAC/FAST, Master. 109pp.
- Direction de la Santé de la Mère et de l'Enfant (DSME). 2011. Protocole national de prise en charge de la malnutrition aigue, pp. 193.
- Houndji, B.V.S., Bodjrenou, S.F., Londji, S.B.M., Ouetchehou, R., Acakpo, A., Amouzou, K.S.S.E. and Hounmenou, C. 2013. Amélioration de l'état nutritionnel des enfants âgés de 6 à 30 mois à Lissèzoun (Centre-Bénin) par la poudre de feuilles de *Moringa oleifera* (Lam.). *Int. J. Biol. Chem. Sci* 7: 225-235.
- Ndong, M., Wade, S., Dossou, N., Guiro, A.T. and Gning, R.D. 2007. Valeur nutritionnelle du *Moringa oleifera*, etude de la biodisponibilité du fer, effet de l'enrichissement de divers plats traditionnels senegalais avec la poudre des feuilles. *AJFAND* 7: 1-17.
- Nergard, C.S., Diallo, D., Inngjerdingen, K., Michaelsen, T.E., Matsumoto, T., Kiyohara, H., Yamada, H. and Paulsen, B.S. 2004. Medicinal use of *Cochlospermum tinctorium* in Mali anti-ulcer, radical scavenging and immunomodulating activities of polymers in the aqueous extract of the roots.

*Journal of Ethnopharmacology* 96: 255-269.

Waswa, L.M., Jordan, I., Herrmann, J., Krawinkel, M.B. and Keding, G.B. 2015. Community based educational intervention improved the diversity of complementary diets in western Kenya: Results from a randomized controlled trial. *Public Health Nutrition* 18 (19): 3406 -3419.

Zongo, U., Zoungrana, S.L., Savadogo, A. and Traoré, A.S. 2013. Nutritional and clinical rehabilitation of severely malnourished children with *Moringa oleifera* Lam. Leaf powder in Ouagadougou (Burkina Faso). *Food and Nutrition Sciences* 4: 991-997.