

A Review of Production and Marketing Standard of *Moringa oleifera* Lam

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Abstract

Moringa (Moringa oleifera Lam) is one of the world's most useful plants. It is known for its nutritional and medicinal benefits, and industrial uses. Moringa and its products are gaining more awareness in developing countries with influx of many producers, however, the recommended standard of processing and packaging as well as good hygienic procedures are not adhered to in the production process. The products are also faced with a number of marketing challenges. The paper is therefore a desk review of literatures and previous studies on production, marketing of Moringa products with a view to sensitising on the production standards. In addition, economic returns and level of profitability of Moringa production were also evaluated. There abound significant business potentials for Moringa leaf powder as long as positive solutions can be found as regards to the creation of public awareness, maintaining product standards and solving marketing challenges.

Keywords: *Economic return, production, processing and packaging standards.*

Introduction

The current food and nutritional crisis in developing countries has further brought Moringa products into limelight (Reyes *et al.*, 2006; Oduro *et al.*, 2008). The poorest cannot afford animal-based proteins as well as most of the synthesized food supplements. The plant has also been found to increase animal productivity as it has therapeutic, nutritional and prophylactic properties (Fahey, 2005). The leaves have also been found to contain immense nutritional value such as minerals, vitamins

and amino acids (Anwar *et al.*, 2007). As such, the leaves have been used to combat malnutrition, especially among infants and nursing mothers (Moyo *et al.*, 2011).

In addition to direct consumption of Moringa leaf, it has also been used for the production of other domestic products (Mekonnen and Gessesse, 1998; Mekonnen, 2003; Enoh-Arthur and Damme 2008). For instance, the powdered leaf has been used for production of juices, food supplements, and sex booster for both

sexes. Furthermore, the leaf is utilised as an input in the production of other products like medicated and herbal soaps and other cosmetic products such as baby ointment, family lotion, massage oil and oil for rheumatism (Jahn, 1996; Hsu *et al.*, 2006; Anjorin *et al.*, 2007; Moyo *et al.*, 2011). In fact, African businesses that manufacture baby formula or nutritional supplements are becoming increasingly interested in Moringa leaf powder due to its cheapness in enriching their products with micronutrients. As a result of the foregoing, Moringa and its products are gaining more awareness in developing countries with influx of many producers.

Despite the potential of Moringa products, it is unfortunate that many of the local and small scale producers in developing countries are not complying with the recommended standard of processing and packaging as well as good hygienic procedures thereby subjecting products to some marketing challenges. Currently, the number of patents on the uses of Moringa is growing in developed countries such as the United States, China, and Europe. There is a need therefore, for African markets to capitalize on this and improve Moringa processing in order to stop the importation of foreign food supplements thereby conserving foreign exchange earnings. It is therefore urgent for developing countries to rapidly switch to using local resources, including Moringa, whose exceptional nutritional value and accessibility make it a clear choice.

Worldwide, some 14 species of the *Moringa* tree (family Moringaceae) have been described. Among these, the best studied species with regard to potential nutritional, medicinal uses and the identification of compounds of potential therapeutic importance is *Moringa oleifera*, which is native to the Indian subcontinent. Another species of Moringa is *Moringa stenopetala*, familiarly known as *Shiferaw* or *Haleko*. This paper therefore focuses on *M. oleifera*.

The study is a desk review of available literature on the production standards and socio-economic potentials of *M. oleifera* products in meeting the needs of people in developing countries. Secondary information was obtained from selected studies and recommended production guides on standards, together with a code of good practices meant to guarantee the good sanitary and nutritional status of *M. oleifera* products. These experiences and practical lessons are pertinent to create awareness and sensitise the emerging producers and marketers of Moringa products strategies of gaining consumers' acceptance and maintaining international standards.

Moringa oleifera Lam

Moringa (*Moringa oleifera* Lam) is one of the world's most useful plants (Foidl, *et al.*, 1999; Oluwalana, *et al.*, 1999; Prajapati, *et al.*, 2003; Anwar, *et al.*, 2007; Asaolu, and Omotayo, 2007; Reyes-Sanchez, *et al.*, 2007; Enoh-Arthur, and Damme, 2008). It is known for its nutritional and medicinal benefits and industrial uses (Table 1). This

fast-growing tree is grown throughout the tropics for human food, livestock forage, medicine, dye, and water purification (Folkard, and Sutherland, 2002). It is known by several names in different countries, but is popularly called the "drumstick tree" for its pods that are used by drummers and the "horseradish tree" for the flavour of its roots.

Almost every part of the *M. oleifera* plant has nutritional values (Jahn, 1996; Hsu *et al.*, 2006). The leaves of Moringa were recently identified by the *World Vegetable Centre* (Taiwan) as the vegetable with the highest nutritional value among 120 types of food species studied. Eating 100 grams fresh *M. oleifera* leaves provides you with as much protein as an egg, as much calcium as a big glass of milk, as much iron as a 200 grams beef steak, as much vitamin A as a carrot and as much vitamin C as an orange, more protein than peas, more potassium than bananas, and more iron than spinach (Moyo *et al.*, 2011).

The pod of *M. oleifera* is cooked as a vegetable in India and exported to many countries for Indian expatriates, fresh or canned (Selvam, 2005). The root can be used as substitute for horseradish. Foliage is eaten as greens, boiled, fried, in soups or for seasoning. Dried leaf powder can be added to any kind of meal as a nutritional supplement. The seed can be roasted and eaten like peanut. The seeds can be used as a flocculent to clarify water and as a source of non-drying and very stable oil, known as Ben oil. This oil, which was once used for

lubricating watches and other delicate machinery, is clear, sweet and odourless, almost never going rancid (Tsaknis, 1999; Abdulkarim *et al.*, 2007). It is edible and it is becoming increasingly popular in the cosmetics industry. Leaves and young branches are used as fodder. Moringa may also be used in fish and poultry feeds. The bark yields a blue dye and can also be used in tanning. The wood can produce paper. A plant growth hormone can be extracted from young shoots, which when applied as a foliar spray, increases yields dramatically in almost any plant. Last but not least, almost every part of the plant has pharmacological properties (Moorthy, *et al.*, 2002; Goyal, *et al.*, 2007; Sabale, 2008).

Production Factors of *Moringa oleifera*

Although different ecological regions in the tropics where *M. oleifera* is produced are different in their climatic and edaphic factors, yet Moringa could tolerate a wide range of environmental conditions (Palada and Chang, 2003). Summary of the production factors that should be considered when going into production of *M. oleifera* include:

Choosing a variety: Among Moringa species, *M. oleifera* and *M. stenopetala* are most commonly grown. *M. oleifera* is most widely cultivated and is the focus of this paper.

Climate and soil requirements: *M. oleifera* grows best between 25 to 35°C, but will tolerate up to 48°C in the shade and can

survive a light frost. The drought-tolerant tree grows well in areas receiving annual rainfall that ranges from 250 to 1500mm (irrigation needed for leaf production if rainfall < 800mm). Altitudes below 600m are best for Moringa, but this adaptable tree can grow in altitudes up to 1200m in the

tropics. Moringa prefers a well-drained sandy loam or loam soil, but tolerates clay. It will not survive under prolonged flooding and poor drainage. Moringa tolerates a soil pH of 5.0–9.0.

Table 1: Plant parts, some useful ingredients in the parts and some uses of each part

Tree Part	Useful ingredients in each parts	Uses or benefits of each parts
Leaves	Hormones, Bioflavanoid, Arachidic acid, Oleic acid, Linoleic acid	Nutritional, forage, biomass, plant growth hormone, medicinal
Flowers	Bioflavanoid, Pterygospermin	Nutritional, medicinal, honey
Fruit		Nutritional, medicinal
Roots		Medicinal
Seed	Arachidic acid, Oleic acid, Linoleic acid	Cosmetics, food, water treatment, medicinal
Wood		Paper, alcohol production, animal feed, medicinal
Stem/Bark	Lignin/cellulose, Alcohol, Bioflavanoid	Rope making, gum for tanning hides, medicinal

Planting methods: Moringa is planted either by direct seeding, transplanting, or using hard stem cuttings. Direct seeding is preferred when plenty of seeds are available and labor is limited. Transplanting allows flexibility in field planting but requires extra labor and cost in raising seedlings. However, transplanted seedlings grow faster in the field than direct seeded seedlings. Stem cuttings are used when the availability of seed is limited but labor is plentiful.

Fertilizing: Moringa grows well in most soils without addition of fertilizer. Once established, the extensive and deep root system of Moringa is efficient in mining nutrients from the sub-soil. For optimum

growth and yields, fertilizers are applied at planting time. Dig trenches around the base of the plant (10–20 cm from the base) and apply approximately 300 g of a commercial nitrogen fertilizer per tree. If commercial nitrogen fertilizer is not available, use compost or well-rotted farmyard manure at the rate of 1–2 kg/tree.

Irrigation: Irrigate newly transplanted trees immediately after transplanting to promote early root development. In dry and arid climates, irrigate regularly for the first two months. Once established, Moringa rarely need watering. The well-rooted tree tolerates drought and needs irrigation only when wilting is evident.

Controlling weeds: Cultivate the soil thoroughly before planting to suppress early weed growth. Apply grass or plastic mulch around the base of each young tree. Maintain a weed-free planting by regularly cultivating between beds and rows.

Controlling pests and diseases: Moringa is resistant to most pests and diseases, but outbreaks may occur under certain conditions. For example, Diplodia root rot may appear in waterlogged soils, causing severe wilting and death of plants. Mite populations can increase during dry and cool weather. These pests create yellowing of leaves, but plants usually recover during warm weather. Other insect pests include termites, aphids, leafminers, whiteflies, and caterpillars. Chemical control of insect pests should be used only when severe infestations occur. Choose a pesticide that targets the specific pest causing the damage, and avoid pesticides that kill or inhibit the development of beneficial organisms. Choose pesticides that last only a few days. Cattle, sheep, pigs, and goats will eat Moringa seedlings, pods and leaves. Protect Moringa seedlings from livestock by installing fence or by planting a hedge around the plot.

Pruning: Moringa should be trimmed to promote branching, increase yields, and facilitate harvesting. If left to grow without cutting the main trunk will grow straight producing leaves and pods only on the primary stem. To encourage the development of many branches and pods within easy reach from the ground, prune

the apical growing shoots when the tree is 1.0–2.0m high. Use a sharp knife, machete, or pruning saw to make smooth cut. New shoots will emerge from just below where the cut is made. Thereafter, cut the growing tips of the branches so that the tree will become bushier. Another pruning strategy is to cut back each branch by 30 cm when it reaches 60cm in length. This will produce a multi-branched shrub. If the tree is being grown for pod production, remove flowers during the first year. This will channel the young tree's energy into vegetative and root development (rather than energy draining pods), leading to more vigorous growth and productive yields in the future. Older trees that are unproductive or too high for easy harvesting can be pruned at ground level. New shoots will emerge quickly from the base.

Harvesting: Moringa leaves can be harvested after the plant has grown to a height of 1.5–2.0m, which usually takes at least one year. Leaves can be harvested by cutting the leaf from branches. Harvesting of young shoot tips will promote development of side branches. Plants should be allowed to develop new shoots and branches before subsequent harvests. Moringa leaves can easily lose moisture after harvesting, therefore, harvest early in the morning and sell the same day, if possible. The leaflets can also be dried in the sun for a few hours and then stored for consumption during the hot-wet season, a time when minerals and vitamins are most lacking in diets. Flowers and pods are normally produced during the second year

of growth. Harvest pods when they are young, tender, and green. They are eaten as green beans. Fresh or dried flowers are also used for making tea.

Collecting and storing ripe seeds: Mature pods contain ripe seeds that are used for planting the next crop or for extracting oil. When producing seed for oil extraction, allow the pods to dry and turn brown on the tree. Harvest pods before they split open and fall to the ground. Store seeds in well-ventilated sacks in a cool, dry, and shaded area. Seeds remain viable for planting for two years.

Standards for Processing and Packaging of Moringa Leaves

Marketing, public acceptability and selling price of the processed Moringa leaf are largely affected by the method of processing as well as packaging of the final products. The Ghana Standard Board, in collaboration with the Moringa Association of Ghana (MAG) and *Moringanews*, and with the financial support of the Center for Development of Enterprise (www.cde.int) has established and published the standards for Moringa leaf powder. The standards, together with a code of good practices and an inspection guide, are meant to ~~mean~~ guaranty the good sanitary and nutritional status of the product. Summary for the standard procedures for processing and packaging of Moringa leaves included:

Stripping the leaflets: Strip all the leaflets from the leaf petiole. This can be done directly from the branches if the leaves

have not been stripped off the main branch before transportation. At this stage, diseased and damaged leaves are discarded.

Washing: Wash leaflets in troughs using clean potable water to remove dirt. Wash leaves again in 1% saline solution for 3-5 minutes to remove microbes. Finally wash again in clean water. Leaves are now ready for drying. Drain each trough after each wash: fresh leaves must always be washed with fresh water.

Draining: Strain water from the leaves in buckets that have been perforated, spread leaflets on trays made with food-grade mesh and leave to drain for 15 minutes before taking them to the dryer.

Drying: There are three main methods for drying Moringa leaves:

(a) *Room drying:* Spread the leaflets thinly on mesh tied on racks (mosquito net mesh can be used) in a well-ventilated room. This room should be insect, rodent and dust proof. Air circulation can be improved by using ceiling and floor level vents protected with a clean filter to keep the sun and dust out. It is possible to use a fan, but the air must not be directly oriented towards the leaves, as it can increase contamination with germs in the air. It is advisable to turn the leaves over at least once, with sterile gloves, to improve uniform drying. Leaves should be completely dry within a maximum of 4 days. However, room-dried leaves cannot be guaranteed mould-free with the maximum recommended moisture content of 10%.

(b) *Solar drying*: Spread the leaves thinly on mesh and dry in the dryer for about 4 hours (Temperature range is 35°C–55°C on a very sunny day). The leaves should be covered with UV treated or opaque polyethylene. The air intake should be filtered to keep out dust. Organza or muslin cloth can be used as a filter. The final product should be very brittle. This method is recommended for both small and large scale processing, particularly for those in rural communities where there is no electricity.

(c) *Mechanical drying*: Drying temperatures should range between 50°C and 55°C. If temperature exceeds 55°C, leaves will "burn" and turn brown. Leaves should be dried until their moisture content is below 10%. This method is recommended for large scale leaf processing as this ensures year round production.

Milling: Mill dry leaves using a stainless steel hammer mill. For personal or household use, leaves can be pounded in a mortar, or milled with a kitchen blender. Small-scale processors can use a burr mill or rent a commercial hammer mill for routine milling of their products.

Sieving: Sieve the leaf powder if need be. When you mill with a hammer mill, the fineness of the product will depend on the size of the screen used in milling. If too coarse, sift using a sifter with the desired screen size. Recommended particle sizes are: Coarse (1.0 mm – 1.5 mm), Fine (0.5

mm – 1.0 mm), and Very fine (0.2 mm – 0.5 mm).

Drying the leaf powder: Moringa leaf powder strongly attracts moisture and the product can reabsorb humidity during or after milling. For this reason, Moringa leaf powder should be dried at 50°C for 30 minutes to reduce moisture content considerably below 7.5%.

Packaging

Moringa leaf products should be packaged in clean, dry and opaque containers made of materials that do not affect the quality of the product. Each package must be properly sealed to prevent content leakage as well as moisture absorption. The temperature and humidity must be controlled in the packaging room, to avoid re-humidification of the product.

Labeling: Each package of Moringa leaf product must be legibly marked with the following information: Name of product; Net content; Name and address of producer; Country of origin; Lot / batch identification number or code; Instructions for use; Production date; and Nutritional information (optional) / Expiry date.

Seasonal production and returns from
Moringa plantations
*Mono-cropping and Intercropping
Plantations of Moringa*

The study on seasonal production and economic returns from plantations of Moringa was conducted in Region of Parakou, north central Benin. The two systems used in the establishment of the Moringa include:

Mono-cropping with irrigation: plantation with density of 12,500 plants/ha (spacing 1m x 0.80 cm). Moringa is the sole culture in the field.

Intercropping without irrigation: Moringa is grown with low-lying cultures such as beans, peanuts or soya bean. The spacing between the Moringa plants was about 5m between the lines and 4m between plants (sometimes 3m x 3m), or a density of 500 plants/ha.

The plantations were made by sowing ~~after~~ ploughing; they were then maintained by weeding and spreading of manure. The harvests started 45 days after the seeds have

sprouted. The first two harvests were cut at a height of 0.50m to shape the tree and help branch formation, then by stripping the leaves as of the third harvest. Subsequently, plants were pruned every year. Harvests were taken every 25 to 40 days in the rainy season (6 harvests) and just once or twice during the dry season. Table 2 presents the mean Moringa leaf yields per hectare for two years in intercrop plantation. Six harvests were made in rainy season for the two years, while only one harvest was made in the first year and two harvests in the second year for the dry season. The six harvests recorded for the rainy season were spread over the rainy season and the fresh season (harmattan); that is from July to the end of January (7 months). The average yield of 490 Kg/ha and 900 Kg/ha were obtained in first and second year respectively.

Table 2: Mean Moringa leaf yields per ha and per year (intercropping)

	Rainy season yield	Dry season yield	Total yield	Average yield per year
One year old plantation*	152 Kg/harvest x 6 harvest = 910 kg	70 Kg/harvest x 1 = 70 kg	980 Kg/ha	490 Kg/ha
Two years old plantation	260 Kg/harvest x 6 = 1560 kg	120 Kg/harvest x 2 = 240 kg	1800 Kg/ha	900 Kg/ha

*A single harvest is best in the dry season to allow the plant to develop correctly, a favourable factor for good production in the second year.

Source: Adapted from *Moringanews*

The seasonal income realised from sales of fresh Moringa leaf at the farm gate during two years for intercropping and mono-cropping are presented in Table 3 and Table 4 respectively. For the rainy season 910 kg/ha of Moringa leaf was produced from

intercropping in the first year and this amounts to 91,000 FCFA (or USD 170). In the second year, the Moringa leaf produced in intercropping system increased to 1,560 kg/ha giving total amount of 156,000 FCFA (USD 291). In the rainy season of mono-

cropping system, 5,400 kg/ha of leaf was produced with total value of 540,000 FCFA in the first year and this increased to 5,940 kg/ha (with total value of 594,000 FCFA or USD 1,110) in the second year. This same trend is observed during the dry season of the two plantation systems with income of 10,500 FCFA or 14,000 FCFA and 50,000 FCFA in the first year and this increased to 36,000 FCFA or 48,000 FCFA and 57,000 FCFA (USD 106) in second year for the intercropping and mono-cropping systems respectively.

Although there are increases in income realised in the mono-cropping system in the two seasons over the intercropping system, yet other produce obtained in intercropping system could make-up for some (if not all) of this differences. Other advantages of intercropping are diversification of the plantation and income security in case of disease and pest outbreak that may reduce yield.

Seasonal production and marketing of fresh Moringa leaves

A study was conducted on seasonal production and marketing of fresh Moringa leaves in Niger Republic (Gamatié and Saint Sauveur, undated). The villages visited are all located on the right bank of the Niger River between 20 and 35km to the northwest of Niamey between isohyets 500 and 600mm of rainfall. In the zones surveyed, four cropping systems were used: plantations with Moringa only (monoculture), Moringa in association with fruit trees in orchards, Moringa as a live hedge on off season sites and Moringa combined either with market gardening. In

the zones surveyed, production of Moringa remains a principal and subsistence activity practiced throughout the year. Producers work on small land holdings (0.01 ha to 0.07 ha). Almost all systems are irrigated, lifting water manually from wells. Three seasons studied include rainy, hot and cold seasons (Table 5). Summary of the results are presented in Table 6. The results indicated that an average producer makes about 298,215 FCFA / year from 0.05 ha of Moringa plantation. On one hectare, the yearly profit would be 596,430 FCFA (or €910). It was suggested that production could be increased through irrigation with motor pumps.

Challenges confronting marketing of Moringa products

A number of challenges have been discovered to confront marketing of Moringa products. The identified challenges of Moringa are as follow:

Adulteration of Moringa powder products:

Due to increased awareness of income derivable from the sale of Moringa products, many producers have compromised the quality of the products. The common production process and packaging of Moringa powder is simple. That is, it could be done in every home with a Moringa tree. The products are poorly labelled or branded. While initially there was high demand for the powder, the influxes of many fake products (with similar colour and taste) are causing reduction in the demand.

Issue of taste: Moringa powder in its pure form is not considered delicious. Lack of

production technology to add value and flavour denies it the market advantage which could accrue to its nutritional potentials.

Competition from imported food supplements: Locally produced food supplements such as Moringa products are normally regarded as inferior to the imported food supplements alternatives. This is a challenge in the marketing of the Moringa powder leaves. Due to more advanced packaging and branding, consumers tend to have more trust in these imported products as they are easy to identify, and most of them are flavoured and have value added.

Poor processing methods: Lack of standard production methods and quality control is another challenge facing marketing of Moringa product. There is inconsistency in the texture of the product between different processors.

Poor Marketing methods: Moringa products have been associated more with medicinal drugs other than food supplements due to poor advertisements. The population is not fully aware of the nutrition values of the product.

Lack of support from concerned institutions on Moringa business: There is inadequate financial support for the producer of Moringa products, especially the processor, in procuring appropriate equipment to use in the processing and packing of the products. The current business trend cannot sustain the commercial interest rates on bank loans.

Conclusion

The study has documented different stages of producing Moringa as well as potential of Moringa products and challenges faced in marketing of the products. Moringa could be produced either in mono-cropping or intercropping systems. Given the world food crisis, the use of local resources like Moringa is critical in improving nutrition among poor households. Two or three trees in a courtyard are also sufficient for the needs of one family. Also, there is significant business potential for Moringa leaf powder as long as positive solutions can be found as regards to the creation of public awareness, maintaining product standards and solving marketing challenges.

The study therefore recommends establishment of quality standards and verifying quality by close supervision of the processors and farmers. Further quality control measures would be enhanced through training of those in the production process. Demand for Moringa could be greatly improved through positive advertisement, branding and packaging, more research on the product and educating the public about the abundant nutritional benefits of Moringa. Lastly, by injecting more funds into the production process, more efficient techniques could be adopted in quality and shelf presentation and thereby eliminate the inferiority concept associated with Moringa products. This could be greatly achieved by government assistance through provision of market incentives and concessions.

Table 3: Sale of fresh leaves at farm gate 1st year (intercropping)

Period	First Year		Second year	
	Price/Kg	Production/ha	Income/ha	Comments
Rainy season	100FCFA	910 kg	91,000 FCFA	6 harvests
Dry season	150FCFA	70 kg	10,500 FCFA*	1 harvest
	or 200FCFA		or 14,000 FCFA*	
			36,000 FCFA or 48,000 FCFA	One harvest only in first year. It is easy to make two harvests during the dry season on the second year
TOTAL		980 kg	101,500 FCFA to 105 000 FCFA	7 harvests
			192,000 FCFA to 204,000 FCFA	8 harvests

**A single harvest is best in the dry season to allow the plant to develop correctly, a favourable factor for good production in the second year.*

Source: Adapted from Moringanews ;

1 USD = 535.26 FCFA

Table 4: Sale of fresh leaves at farm gate 1st year (mono-cropping)

Period	Price/Kg	First Year			Second year	
		Production/ha	Income/ha	Production/ha	Income/ha	
Rainy season	100 FCFA	5,400 kg	540,000 FCFA	5,940 kg	594,000 FCFA	
Dry season	150 FCFA or 200 FCFA	333 kg	50,000 FCFA	384 kg	57,600 FCFA	
TOTAL		5,733 kg	590,000 FCFA	6,324 kg	651,600 FCFA	

Source: Adapted from *Moringanews* ;
1 USD = 535.26 FCFA

Table 4: Estimate of the number of harvests per year for selected producers in Niger

Seasons	Duration	Frequency of harvest	Number of harvests
Rainy season	3 months	2 weeks	6 harvests
Hot season	5 months	3 weeks	7 harvests
Fresh season	4 months	3 weeks	5 harvests
Total Year	12 months		18 harvests

Table 5: Profit from the sale of fresh leaves on the urban market

	Rainy season	Hot season	Cold season	Total per year
Production (bags)/0.05ha	60 bags	35 bags	63 bags	
Production (kg)/0.05ha	900 kg	525 kg	945 kg	2370 kg
Selling price	1750 / 15kg = 117 FCFA / kg	3000 / 15 kg = 200 FCFA / kg	3500 / 15 kg= 233 FCFA / kg	
Profit made by an average producer on 0.05 ha	11,800 x 6 harvests= 70,800	13,129 x 5 harvests = 65,645	23,110 x 7 harvests= 161,770	298,215 FCFA (455 €/0.05 ha)
Profit per kg	79	125	171	126

1 € = 655.42 FCFA

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