The Trajectory of Sustainable Development

Volume 7, Issue 1, December 2023

Formerly: Journal for Worldwide Holistic Sustainable Development (JWHSD), ISSN2409-9384 (online version) & ISSN 2414-3286 (print version)

Recommended Citation: Yakubu, F. B., Akinyele, A. O. (2023). "EFFECT OF SCION SOURCES ON PERFORMANCE OF *Chrysophyllum albidum* Linn (Sapotaceae) SEEDLINGS". The Trajectory of Sustainable Development, 7, 36-53. Available at: https://www.hsdni.org/journal/articles/ .

EFFECT OF SCION SOURCES ON PERFORMANCE OF *Chrysophyllum albidum* Linn (Sapotaceae) SEEDLINGS

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Abstract

The effects of scion sources and mother trees on the early growth performance of grafted seedlings of *Chrysophyllum albidum* was investigated. Seeds were germinated in FRIN nursery and 150 uniformly grown seedlings were selected as rootstocks for grafting. Scions were collected from three locations and used for grafting. Data were analysed using descriptive statistics and ANOVA at $\alpha_{0.05}$. Highest survival per(Mother tree) MT of *C. albidum* were14.0% and 12.0% in GFR and OlFR, while the least survival per MT of *C. albidum* was 0% and 4% in OLFR and OFR, respectively. Grafted *C. albidum* seedlings had the highest height (59.9±5.11 cm) and highest number of leaves (16.0±2.25) from OLFR. In general, there was a high compatibility of scion from Gambari Forest Reserve with the rootstock from different sources.

Key words: Fruit trees domestication, Modified Cleft Grafting, *Chrysophylum albidum*, Scion source

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Introduction

The improvement programmes of forest trees is generally timber-oriented, except in the last few years that high-valued agroforestry tree species for fruits/nut production have been the subject of domestication and improvement of yield and quality (Leakey 1999, Leakey *et al.* 2005). There are new initiatives in tropical forest tree improvement aimed at developing cultivars of trees with desired fruits, nuts, and medicinal characteristics (Leakey *et al.* 2005). In Southern Sahana countries, Indigenous Fruit Trees (IFTs) serve as alternative sources of food, especially during planting season. Most food crops are in maturing stage and only Multi-purpose Trees Species (MPTs) are the main crops for rural economic support. The edible parts of these tree species could be processed into conventional products like jams, marmalade, alcohol, soaps, candles, jelly and chewing gums, table oil, margarine, etc. (Shiembo *et al.* 1996, Adisa 2002).

Despite the importance of these IFTs, they have been greatly neglected especially with respect to their regeneration and improvement through vegetative propagation. The yield of most valuable tree crops is decreasing due to long years of production. Thus, if the current practice of leaving these IFTs to grow in the wild should continue, the probability of producing its much-valued fruit on a sustained basis will be very low. Due to the lack of care and old age, a lot of the trees of these species have died or are in the process of doing so. In Nigeria, *Chrysophyllum albidum* is classified among the endangered tree species (Olajide *et al*. 2008), with a high possibility of going into extinction soon except conscious effort is made to conserve these species or increase their populations employing various silvicultural interventions.

Among the MPTs, *C. albidum* belongs to the basic IFTs that are of economic importance, and are currently vulnerable to extinction problems (Akinnifesi *et al.* 2006). *Chrysophyllum albidum* and other fruit tree species when propagated by seeds do not ensure the preservation of mature parental traits. Vegetative methods ensure the true-to-type production of IFTs cultivars. It is known that vegetatively propagated plants primarily depend upon location of the tree and proper grafting method to be successful (Khan *et al.* 2002). Vegetative propagation techniques

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are the most effective method to produce planting stocks for the production of true-to-type plants (Ismail *et al.* 2002). The success of grafting methods varies from species to species. Grafted IFTs like *Irvingia wombolu* bear fruits in 5 – 6 years while the non-grafted trees will take 20 – 25 years (Yabuku *et al.* 2011).

However, grafting for commercial propagation of IFTs has been restricted because of poor success which is since the rootstock and scion may not be compatible. This could be as a result of cambiums not matching properly for contact or scions are upside down, grafting done at the wrong time, rootstock or scion are not healthy and the graft is not properly covered with grafting wax. At times, it may be due to attacks by insects or disease, or the graft union is girdled because the tape was not cut or released in time (Ray & Starbuck 2002)..

Chrysophyllum albidum is a forest tree species which belongs to family Sapotaceae. It is primarily a lowland rainforest tree species that is often planted in villages, its natural occurrences have been reported in diverse ecological zones (Bada 1997). It is a medium to big sized tree and it grows up to 36 m height and about 2m in girth. Bole sometimes long and straight but often branched low-down, deeply fluted, sometimes with small (30 cm high) buttressed at the base. The bark is pale grayish brown. The leaf is oblanceolate tapering rather to the accumulate apex and wedge-shaped base, lower surface is densely covered with silvery-white or slightly yellowish hair, lateral nerves in 10-15 pairs venation on upper surface invisible or indistinct (Keay 1989).

Ladipo*et al. (*1997) reported substantial morphological variations in vegetative and reproductive characteristics, including fruit quality attributes common to most indigenous fruit trees species. Keay (1989) described the differences in the fruits between the African *Chrysophyllum* species. These are *C. subundum, C. albidum, C. gigateun, C. delevoyi and C. perpuchrum.* In Nigeria, phenotypic and physiological variations include tree size, tree crown shape, branching and stem buttressing, fruit yield. The shape of the fruits can vary a lot with colour, size, shape, sweetness and pulpiness. Given the economic importance of *C. albidum* and the reproductive challenges of this species, the present study investigates the effects of scion

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materials from mother trees on the survival and early growth performance of its grafted seedlings. The research was carried out on the grafting of scions on the rootstocks of plant materials from three different locations in Southwestern Nigeria

Materials and Methods

Study site

This study was carried out at the West African Hardwood Improvement Project (WAHIP) nursery in Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State. FRIN is located on the longitude 07°23'18"N to 07°23'43"N and latitude 03°51'20"E to 03°51'43"E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9°C, minimum 24.2°C while the mean daily relative humidity is about 71.9% (FRIN, 2015).

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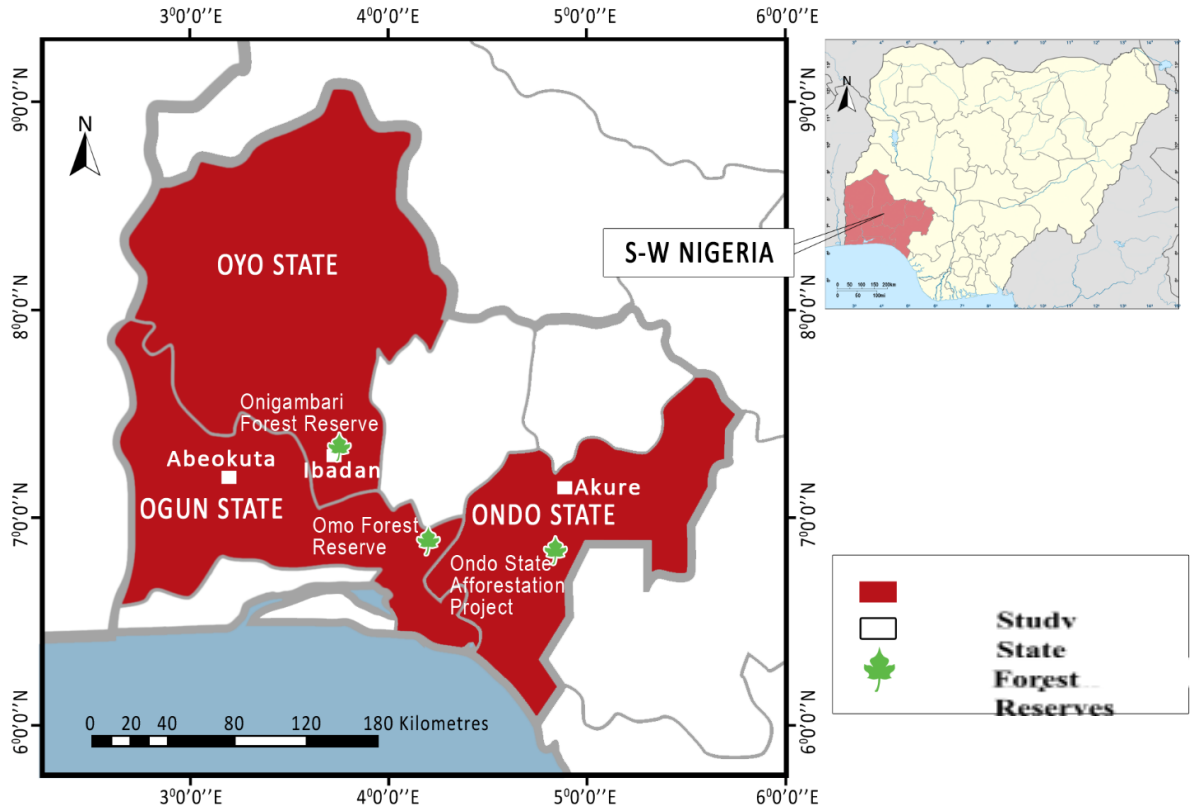

Figure 1. Map of South Western Nigeria showing the collection areas

Collection of plant materials

The scion for the tree species (*Chrysophyllum albidum)* were collected from three different locations in Southwestern Nigeria namely; Oyo (Gambari Forest Reserve), Ogun (Omo Forest Reserve), Ondo (Oluwa Forest Reserve) (Figure 1). Ten (10) scions were collected from each of the mother trees. The seeds for the root stock of *C. albidum* were collected from FRIN arboretum. A total of 150 seedlings of *C. albidum* were raised for one year at the Fruit Trees Nursery, Sustainable Forest Management Unit, FRIN and prepared for grafting.

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Experimental design

The experimental design is Completely Randomized Design (CRD). The experiment comprised of three treatments (location) namely; Oyo (Gambari Forest Reserve), Ogun (Omo Forest Reserve) and Ondo (Oluwa Forest reserve). Each treatment is replicated fifty (50) times.

Statistical design for CRD

The statistical model is:

$Y_{i,j,} = \mu + Ti + e_{i,j}$……Eqn 1

Where,

$Y_{i,j,}$ = Individual observation
μ = Overall mean
T_i = Effect of scion location
e_{ij} = Experimental error

Experimental procedures

Fifty scions of each IFT species were collected from each location Oyo (Gambari Forest Reserve), Ogun (Omo Forest Reserve) and Ondo (Oluwa Forest reserve), making a total of Three hundred scions, fifty for each of the species making 150 for each of the two species and 300 rootstock for the study making 150 per species. The scions were collected from matured trees of *C. albidum.* The grafting experiment was Modified Cleft Grafting (MCG) according to Yakubu *et al.* (2011).

Grafting

The scions were identified and collected from selected mother tree. One year old (green bud-120mm diameter) scions were selected from branches at an area that was close to the center of the canopy using ladder. Wet jute material was used to wrap the collected scion and placed inside transparent polythene sheet to avoid desiccation during transportation to the nursery site for grafting.

A clean slant cut was made from the bark of the rootstock to the pith using a very sharp sterilized budding knife (Plate 1). The slits cut (tongues) from the scion about 2.5 – 3.5 cm deep

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was matched unto the surface of each cut of the rootstock. The graft was made by gently pushing the scion into the rootstock and interlocking the tongue. This was wrapped with a budding tape, winding from the bottom up, and slipping the end under the final loop. The prepared stocks were placed under mist propagator chamber for 4 weeks. Once the scion and stock remain green after 4 weeks, the stock from the point of union was cut off to allow the scion and the root stock to develop. The grafted plant stocks were left inside the propagator chamber for another 4 weeks to stabilize before removing to weaning shed. Watering was carefully done from the base to avoid water entering the point of union and subsequent decay of grafts.

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Data collection and analysis

Data was collected on the survival percentage (success rate) of the grafted seedlings of *C. albidum* after 4 weeks. Ten survived grafted seedlings were selected from each species and monitored for growth characteristics for five months. Watering was done daily. Data were collected on the development of the grafted seedlings by measuring the following: height (cm) with a ruler, collar diameter (mm) with a digital caliper and visual count for number of leaves for a period of 6 months.

Data collected on survival of the grafted seedlings were subjected to descriptive analysis while analysis of variance (ANOVA) was used to compare the effects of the scion collected from the different locations on the early development of grafted *C. albidum*. Significant means were separated using least significant difference (LSD).

Plate 1. Grafted *C. albidum* seedlings under propagator chamber

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Results

Survival of grafted *C. albidum* Seedlings

The result revealed that *C. albidum* scion collected in Gambari Forest Reserve performed best compared to the other scions collected from Omo Forest Reserve and Oluwa Forest reserve. Analysis of variance indicated that there were significant differences ($p \leq 0.05$) in the height of grafted *C. albidum* scions collected from the three locations (Table 1). There was also significant difference ($p \leq 0.05$) in the leaves produced from the scion materials. Mean grafted scion height ranged from 42.82 to 59.95 cm with the highest mean height from grafted seedlings from Oluwa forest reserve. Similarly, mean grafted scion leaf production ranged from 3 to 16 leaves with the highest leaves produced by grafted seedlings from same location (Table 2). Futher, mean separation result revealed that the height of grafted seedlings from Gambari forest reserve and Omo forest reserve were not significantly different from each other while the height of grafted seedlings from Oluwa forest reserve were significantly different from the height of grafted seedlings from the other two locations (Table 2). However, this result (mean separation) showed that leaves produced by scion of grafted seedlings collected from the three locations were significantly different from each other (Table 1). Although, larva was found on the leaves of the grafted seedling after six weeks after grafting (Plate 2). The mean grafted scion collar diameter ranged from 9.11 to 11.60 mm with the highest mean collar diameter from Oluwa forest reserve (Table 1 & 2). Mean separation result revealed that collar diameter of grafted seedlings from Gambari forest reserve and Omo forest reserve are not significantly different from each other while the collar diameter of grafted seedlings from Oluwa forest reserve were significantly higher from the collar diameter of grafted seedlings from the other two locations (Table 2).Seedlings of *C. albidum* grafted with scions collected in Gambari Forest Reserve had the highest survival rate of 36%, followed by scions collected from Omo Forest Reserve which had 34% survival rate while scions collected from Oluwa Forest Reserve had the least survival rate of 20% (Figure 2).

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Table 1. Analysis of variance result for the effect of scion sources on the height, collar diameter and number of leaves of *C. albidum* grafted seedlings

Parameter	SV	Df	SS	MS	F	Sig.
Height	Location	2	1543.12	771.56	5.74	0.01*
	Error	27	3632.23	134.53		
	Total	29	5175.35			
Collar Diameter	Location	2	40.21	20.11	9.31	0.00*
	Error	27	58.31	2.16		
	Total	29	98.52			
Number of Leaves	Location	2	769.40	384.70	11.79	0.00*
	Error	27	880.90	32.63		
	Total	29	1650.30			

- Significant (p≤0.05)

Table 2. Mean height, collar diameter and number of leaves of grafted *C. albidum* seedlings

Location	Height (cm)	Collar Diameter (mm)	Number of Leaves
Gambari forest reserve	48.01 ± 2.99^{ns}	9.11 ± 0.31^{ns}	3±1.11*
Omo forest reserve	42.82 ± 2.31^{ns}	9.19 ± 0.53^{ns}	10±5.90*
Oluwa forest reserve	59.95±5.11*	11.60±0.52*	16±2.25*
LSD Value	5.19	0.66	2.55

The mean is significant at the level 0.05

Further results through descriptive statistics revealed that mother tree source for scion collected in Gambari forest reserve had the best survival, compared to the other mother trees

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sources in Omo forest reserve and Oluwa forest reserve. Scions of *C. albidum* collected from mother tree 3 in Gambari forest reserve had the highest survival rate of 12%, followed by scions of *C. albidum* collected from mother tree 2 had survival rate of 10%, followed by scions of *C. albidum* collected from mother tree 5 which had survival rate of 6%, followed by scions of *C. albidum* collected from mother tree 1 and 4 which had 4% respectively. Scion collected from mother tree 3 in Omo forest reserve had the highest survival rate of 10%, followed by scion of mother tree 1 had survival rate of 8%, followed by mother tree 4 and 5 had 6% respectively. Scion from mother tree 2 had 4%. Scion collected from mother tree 5 from Oluwa forest reserve had the highest survival rate of 6%, followed by scion collected from mother tree 2, 3 and 4 had same survival rate of 4% respectively. Lastly, scion collected from mother tree 1 had 2% survival rate (Table 3)

Table 3. Effects of Mother tree on mean survival % of*C. albidum*

Mother Trees	OLFR	OFR	GFR	Pooled mean
Mother Tree 1	2	8	4	5
Mother tree 2	4	4	10	6
Mother tree 3	4	10	4	6
Mother tree 4	4	6	12	7
Mother tree 5	6	6	6	6

- Ten (10) scions were collected from each of the mother trees

OLFR= Oluwa forest reserve
OFR= Omo forest reserve
GFR= Gambari forest reserve

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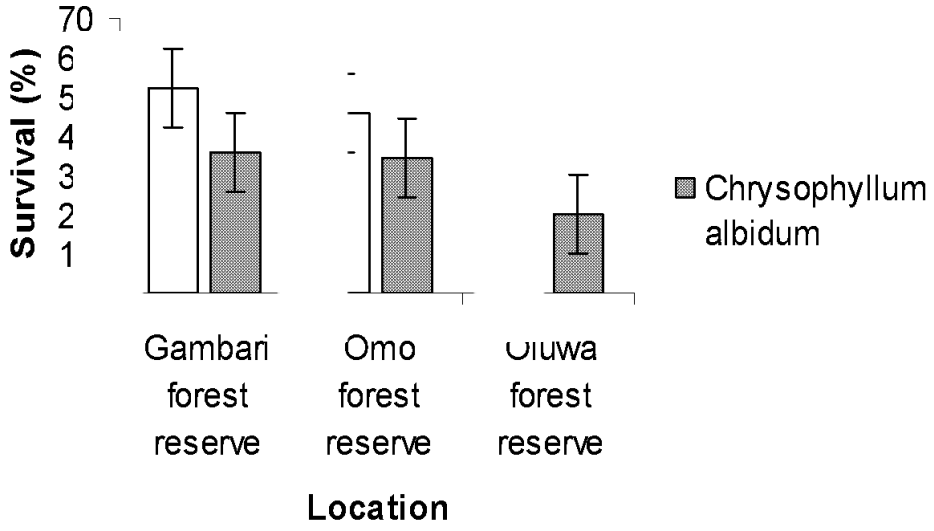

Figure 2. Survival percentage of grafted Seedlings of *C. albidum* from three locations.

Plate 2. Flowering seedling of *C. albidum* five months after successful grafting.

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Discussion

Grafting success of *C. albidum* was high with the scions collected in Gambari Forest Reserve compared to the scions collected from Omo Forest Reserve and Oluwa Forest Reserve. The scions collected in Gambari Forest Reserve were grafted almost immediately after collection. This resulted to the higher survival percentage of scions collected from Gambari Forest Reserve. Location to the grafting site and the latex produced by *C. albidum* might cause reduction in the survival percentage. *Chrysophyllum albidum* are found to have latex cells and vessels and upon cut, produce milky juice which tends to make grafting and budding difficult to heal and establish. The result of this study shows that scion sources affected the survival percentage of scion after grafting. This is in correlation with the work of Munjunga*et al.* (2013) who reported that scion sources affected the survival percentage of scions grafted on *Allanblackia stuhlmannii* seedlings. The results indicated that *C. albidum* can be successfully grafted using the modified cleft method. This has been previously demonstrated by Yakubu *et al*. (2011 & 2014). In many species, it has been reported that cleft grafting is easier to use (Sanou*et al.* 2004; Manna *et al.* 2006) and more successful than other methods of grafting (Hibbert-Frey*et al.* 2010). However, in other species moderate temperature and high relative humidity are major factors related to success of grafts (Yelleshkumar*et al.* 2008).

The pathogenic microorganism found on the scion and the point the graft cut was made were fungi. These fungi were only found growing on *C. albidum* grafted seedlings. *A. niger*, *G. candidum*, *M. racemosus* and *M. heimalis* were found on *C. albidum* grafted seedlings. *Streptomyces gallous* was only bacterium found on *C. albidum*. The fungi found on *C. albidum* grafted seedlings contributed to the reduction in the survival rate of the grafts. Incidence of disease caused by pathogens has been reported in the literature to be one of the most common environmental causes of grafting failure (Hartmann *et al.* 2002 & Sanou*et al.* 2004).

The increase in the height of scion grafted on *C. albidum* seedlings supports the work of Yakubu *et al*. (2014). The result from this study showed there was significant difference in the height of shoots produced from scion grafted on *C. albidum* seedlings. The result on the shoot height of

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C. albidum is not in correlation with the findings of Anjarwalla*et al*. (2017) who reported no significant difference in the shoot height of grafted *Adansonia digitata* seedlings using scions from two different sources.

The result from this study also showed significant difference in the collar diameter and leaf production of scions from different locations grafted on *C. albidum* seedlings. The significant differences in the collar diameter and leaf production of scions from the different locations grafted on *C. albidum* seedlings might be due to some genetic differences between the individual trees as similarly shown for *Cola nitida* by Dadzle *et al*. (2014). As further observed in this study, the larva identified on the leaves of *C. albidum* caused a drastic reduction in the leaves of grafted *C. albidum* seedlings. So far, there is little or no information with regard to performance of scions collected from different locations on *C. albidum* and other economic fruit tree species in Nigeria from the literature. Thus, this work provides basic and advanced information on grafting of indigenous fruit trees, an important aspect of indigenous fruit trees improvement in Nigeria.

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Conclusions

The results of this study showed that Modified Cleft Grafting (MCG) techniques can be used as a propagating technique in *C. albidum*. Scion collection from long distance location to grafting site affected the percentage survival of grafts of *C. albidum*. Scion collection location should not be far where possible from the grafting site. Copious latex production by *C. albidum* stems could contribute to graft failure. The development and propagation protocols contributed to the development of *C. albidum* domestication, which includes the selection, mass propagation and on-farm cultivation of superior *C. albidum* trees, for example, early and regular fruiting, higher fruit yields, higher proportion of pulp in the fruits and higher nutrient contents in the fruit pulp. The problems associated with these species are the production of copious exudates /latex which hinders callus formation. The high level of sugar content helps the development of fungi which is a common problem with fruit tree species grown in the tropics and this hinders the survival rate of grafted seedlings.

Grafting process should be carried out in a controlled environment and sterilized tools should be used during the process as these will help to reduce the fungi infection thereby increasing survival rate of the grafts. Domestication and cultivation of *C. albidum* through grafted seedlings will enhance the conservation of these species.

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Volume 7, Issue 1, December 2023

Formerly: Journal for Worldwide Holistic Sustainable Development (JWHSD), ISSN2409-9384 (online version) & ISSN 2414-3286 (print version)

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