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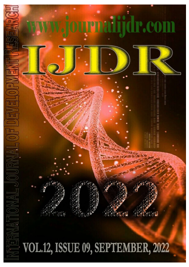

RESEARCH ARTICLE

OPEN ACCESS

GROWTH OF THE MANGROVE OYSTER CRASSOSTREAGASAR (DESHAYES, 1830) REARED WITH SUSPENSION TECHNIQUES ON THE COASTAL LAGOON IN BENIN, WEST AFRICA

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ABSTRACT

The exploitation of the mangrove oyster *Crassostreagasar* is an income-generating activity for the riparian populations of the lagoons of southern Benin. The traditional bottom farming is the most widespread oyster farming method along the coastal lagoon. This study aims to cultivate the oyster with suspension techniques in order to increase oyster production. Rearing trials were carried out between September and October 2017 with vertical suspension technique, horizontal suspension technique and the floating line in different stations. At each station, both a suspension technique and traditional oyster culture method were experimented. Juveniles oyster of 50 to 54 mm size were cultivated .The growth parameters (K and L∞) of the von Bertalanffy equation as well as the growth rate were estimated and the survival rate was calculated for each of the trials. Growth parameters recorded for vertical suspension (K= 0.055 day^{-1}; L∞ = 95.35 mm), horizontal suspension (K= 0.154 day^{-1}; L∞ = 65.21mm) and floating line(K = 0.055 day^{-1}; L∞ = 93.78 mm) are higher than the values of the same parameters for traditional rearing (K between 0.054 and 0.113 day^{-1}; L∞ between 60.024 and 84.15 mm). Daily growth rates reached 0.31; 0.33 and 0.36 mm/day with the new techniques respectively in Dégouè, Sèyigbé and Djègbadji while they are 0.14; 0.17 and 0.19 mm/day in the same order. Survival rates are higher (95 to 97.5%) in the suspension techniques in contrast to the traditional farms (67.5 to 80%). The oyster *C. gasar* showed better survival rate and growth performance with the suspension techniques indicating promising prospects for its culture.

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INTRODUCTION

The importance of oysters in the world is undeniable in terms of food, ecology and economy (Tamburri *et al*., 2008, Adité *et al*., 2013; Akélé *et al*., 2014). The exploitation of these bivalves has increased in developing countries due to the growing demand for animal protein. The demand for edible oysters in the face of limited oyster production is at the root of this overexploitation (Akélé, 2015). Among the solutions discussed to address overexploitation of oysters, many researchers have highlighted strategies for regulated management of natural stocks and the development of aquaculture of these bivalves (Ansa and Bashir, 2007; Adjei-Boateng *et al*., 2012). To mitigate the collapse of wild stocks of bivalves in West Africa, the promotion of their traditional culture (farming under natural conditions) has been mentioned by several authors (Ansa and Bashir, 2007; Adjei-Boateng *et al*., 2012; Adjei-Boateng and Wilson, 2013; Crow and Carney, 2013). Developing the cultivation of a species requires technical knowledge about its growth and survival performance in cropping systems (Urban, 2000; Adjei-Boateng and Wilson, 2013). With this in mind, several studies have attempted to assess the aquaculture potentials of the most common oysters in West Africa (Diadhiou, 1995; Ansa and Bashir, 2007; Akele, 2015; Akele *et al*., 2022). Among them, the mangrove oyster *Crassostreagasar* appears in the first ranks (Ansa and Bashir, 2007; Akélé *et al*., 2022). In Senegal, for example, the promotion of the development of traditional oyster farming of the mangrove oyster *Crassostreagasar* in Casamance has been a success for African oyster farming (Diadhiou, 1995). In Benin, *Crassostreagasar* populates the brackish waters of Lake Nokoue and the coastal lagoon (Senouvo, 2003; Adité *et al.,* 2013a; Agadjihouèdé *et al*., 2017) but its farming remains traditional (Kinkpé *et al*., 2005; Akélé *et al*., 2022). Traditional rearing beds are delimited with wooden stakes and then the oysters are placed on the ground at the bottom of the water. At the end of the rearing cycle, oyster aquaculturists record a low oyster yield. The introduction of off bottom farming techniques appears to be an option to increase the productivity of oyster farming sites and improve the income of the fishermen. This study assessed the contribution of suspension techniques, based on local materials, to the improvment of *C. gasar* culture along the coastal lagune

MATERIALS AND METHODS

Study area and experimental sites selection: Experimentation was conducted on the coastal lagoon in the commune of Ouidah in southern Benin. The commune of Ouidah (6°22'0"N 2°4'60"E) has a Sudano-Guinean climate, characterized by two rainy seasons alternated by two dry seasons of unequal duration. The average temperature is 27°C, varying from 24° to 30°C in the rainy season and from 23° to 33°C in the dry season. The choice of the rearing sites was naturally made towards the traditional oyster farming sites. The first step was to identify the sites where growth could be best (high primary production). These sites should have a satisfactory plankton richness, less fluctuation in salinity and temperature, better bacteriological quality and easy access for work (Gilles, 1992; Adité *et al*., 2013b). For this study, three (03) sites meeting the previous criteria have been selected. mentioned selection criteria. These were Djègbadji, Sèyigbé, and Dégouè, all traditional oyster farming sites in Ouidah (Figure 1).

Spat collection and stocking: The spat was collected by women oyster collectors from the village of Djondji located 21 km from Djègbadji, 15 km from Dégouè and 17 km from Sèyigbé (Figure 1). These spats were transported early in the morning between 6 and 7 a.m. with plastic containers to the different experimental sites. At each site, a specific suspension technique was experimented along with the traditional bottom method. The off bottom rearing techniques such as vertical suspension, horizontal suspension and floating lines were tested respectively at Djègbadji, Sèyigbé and Dégouè.

At each site, two batches of 40 juvenile oysters of size varying between 50 and 54 mm were cultivated: a control batch for the traditional rearing and the second batch for the off bottom technique. The gluing of the oysters is the first step of all the suspension culture techniques. Indeed, the oysters were glued to the ropes for the elaboration of the experimental techniques. Indeed, they were placed two by two between the ropes, at regular intervals of about 10 cm. The right valve is put against the rope so that the inner hinges of the two oysters touch each other to ensure the solidity of the fixation. A mixture of cement and water, similar in consistency to strong cement, is placed between the rope and the oysters. Drying is done for 24 hours.

Suspension oyster culture techniques

Breeding in vertical suspension: The vertical suspension technique consists in arranging the ropes of glued oysters in a vertical position. The ropes have an average length of 1.5 m and support two doublets of glued oysters. The ropes carrying the oysters are attached to the stakes. Finally, the oysters glued to the ropes are immersed in the water (Figure 2).

Table 1. Von Bertalanffy Growth parameters, growth rate and survival rate of oysters reared in different stations of the coastal lagoon with suspension methods and traditional culture technique (Control)

Stations	Djègbadji		Sèyigbé		Dégoué	
Farmingtechniques	Traditional culture method	Vertical Suspension method	Traditional culture method	Horizontal suspension method	Traditional culture method	Floating line
K (day^{-1})	0.054	0.055	0.113	0.154	0.047	0.055
L∞ (mm)	77.82	95.35	60.024	65.21	84.15	93.78
GR (mm/day)	0.14	0.36	0.17	0.33	0.19	0.31
GR (mm/month)	4.2	10.8	5.1	9.9	5.7	9.3
Survival rate (%)	72.5	95	67.5	97.5	80	95

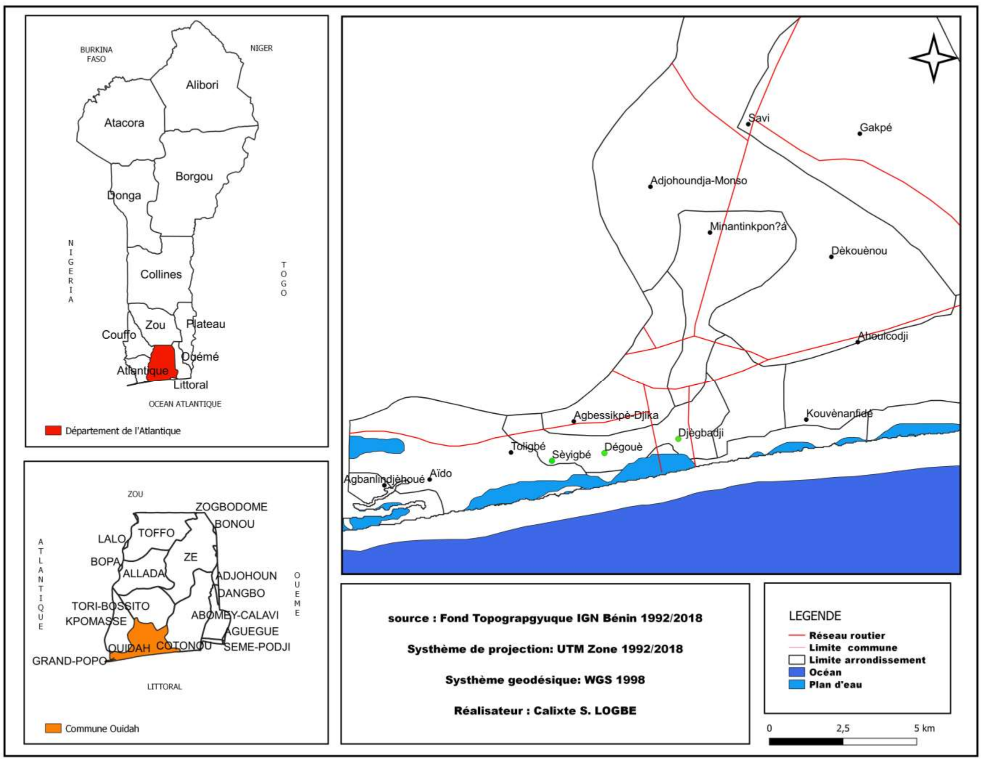

Figure 1. Experimentation sites for new *C. gasar* rearing techniques in the coastal lagoon in Benin

Figure 2. Oyster farming with vertical suspension technique

Horizontal suspension culture: For this technique, lines of oysters glued in doublet were attached to two horizontally arranged wooden supports (Figure 3). Each pair of supports had 5 lines of glued oysters. The lines were 2 m long with 4 doublets of glued oysters. The oyster racks were attached to stakes so that the oysters were immersed in water to a depth of 1.5 m from the surface.

Figure 3. Oyster farming with horizontal suspension technique

Rearing with floating line: The floating line technique is often applied on sites with a depth of less than 1 m. This technique requires a structure composed of three long parallel lines that float on the surface of the water through conventional canisters. At the end of the installation, the glued oysters are immersed in the water and the canisters serve as supports and floats (Figure 4).

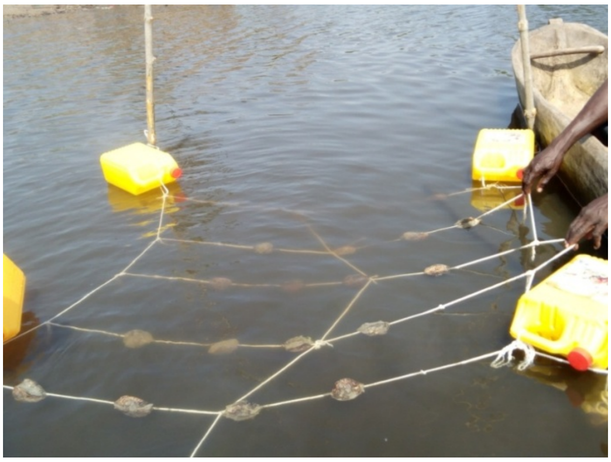

Figure 4. Oyster farming with floating line technique

***Monitoring of the trials and measurement of morphological parameters*:** The experimentation lasted thirty six (36) days between September and October 2017. Shell length and number of dead individuals were surveyed at regular four-day intervals early in the morning between 6 and 7 AM. Data were collected at the sites on a rotational basis. Dead specimens were counted and removed from trials to assess mortality rates.

Data processing and statistical analyses: The linear growth rate was estimated for oysters cultured at the different stations. Of the various equations used in the literature for describing mollusc growth curves, the Von Bertalanffy growth function provides the best fit for bivalve growth (Adam, 1990). The growth equation is as follows (von Bertalanffy, 1938) :

$$TL = L\infty(1 - e^{-K(t-t0)})$$

Where TL = total length of the animal at time t; L∞ = value of TL when the rate of increase is zero; K = characteristic constant of growth, it indicates the rate at which the size approaches L∞; t = age (expressed in days, months, years, etc.); to = hypothetical time at which the animal would have had size 0. The infinite length or size L∞, which is determined by the intersection of the fit line with the y-axis (L in mm), corresponds to a zero rate of increase. It an estimate of the mean maximum theoretical size from observational data. The von Bertalanffy growth parameters (K and L∞) were estimated by the Ford-Walford method (Walford, 1946). Thus, the length (Lt+1) at age t+1 (in days) is constructed as a function of the length (Lt) at age t. The equation of the best-fit line of the regression is of the form: Y = α + βx where β is the slope and α is the point of intersection of the best-fit line on the y-axis. L∞ is given by the formula: L∞ = [α / (1-β)]. The growth rate K is calculated as the natural logarithm of the inverse of the slope according to the formula (Gulland, 1969): K = ln (1 / β)
In addition, the average growth rate (GR) or rate of increase was estimated according to the formula: GR = (Xt+1-Xt)/D Where Xt+1 is the average shell length (mm) at the end of the current month, Xt is the shell length in the previous month, and D is the number of days between two consecutive observations. The survival rate (SR) was calculated according to the formula: SR (%) = (Nf / Ni) x 100, Where Ni = initial number of individuals and Nf = number of individuals at the end of the experiment. The comparison of survival rates between the new techniques and the traditional farms was performed using the χ^2 test. The difference was considered significant at the 5% level. This analysis was performed with PAST 3.04 (Palaeontological Statistics Software).

RESULTS

Growth parameters and survival rate: The growth and survival parameters of oysters after 36 days of rearing are summarized in Table 1.

Survival rate: Oyster survival rate ranged from 95 to 97.5% in the new farming techniques (Table 1). In contrast to the new techniques, survival ranged from 67.5 to 80% in the traditional farms (Table 1). However, there was no significant difference between the survival recorded with the new rearing techniques and that of the traditional oyster farming($p > 0.05$).

Growth of oysters reared with vertical suspension technique at Djègbadji: After an adaptation phase of one week, the growth of oysters cultivated in vertical suspensionexhibited high variation from 54 mm (D8) to 77 mm (D36), an increase in size of 12 mm (Figure 5). In contrast, oysters reared flat on the ground grew linearly from 64 mm (D8) to 69 mm (D36), an increase of 5 mm (Figure 5). The growth in size of oysters reared in vertical suspension was double that of individuals reared on the ground (Figure 5). The von Bertalanffy growth parameters (from the traditional technique K = 0.054 day^{-1} and L∞ = 77.82 mm) are lower than the values from the vertical suspension technique (K=0.055 day^{-1} and L∞ = 95.35 mm). The growth rate of oysters in vertical suspension (GR = 0.36 mm/day) is 2.5 times higher than that in flat culture (GR = 0.14 mm/day) (Table 1).

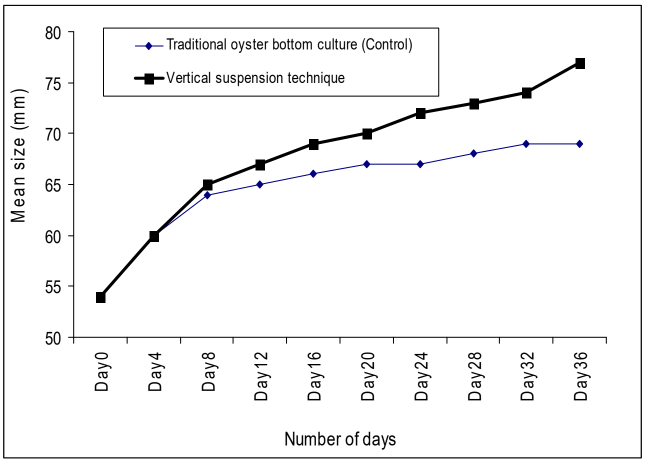

Figure 5. Variations of the mean size of specimens of mangrove oyster *Crassostrea gasar* cultivated with traditional method (bottom culture) and vertical suspension technique at Djègbadji.

Growth of oysters reared with horizontal suspension technique at Sèyigbé: Growth was spontaneous without any adaptation period, probably because of the small size of the specimens. The average size of spat cultivated in vertical suspension varied from 50 mm (D0) to 62 mm (D36), an increase of 12 mm.

In contrast, the specimens in traditional culture grew from 50 mm (D0) to 56 mm (D36), showing an increase of 6 mm of growth (Figure 6). The von Bertalanffy parameters of oysters with vertical suspension method (K = 0.154 day^{-1} and L∞ = 65.21 mm) were significantly higher than those of ground-reared individuals (K = 0.113 day-[1] and L∞ = 60.024 mm). The rate of increase in horizontal suspension (0.33 mm/day) is twice that of conventionally reared individuals (0.17 mm/day) (Table 1).

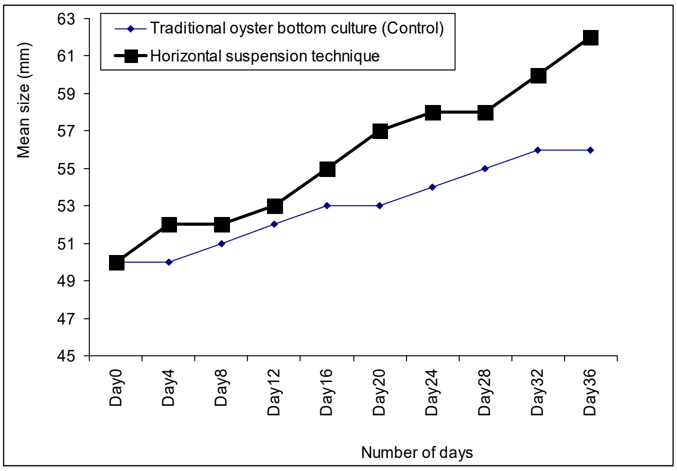

Figure 6. Variations of the mean size of specimens of mangrove oyster *Crassostrea gasar* cultivated with traditional method (bottom culture) and horizontal suspension technique at Sèyigbé

Growth of oysters reared with floating lines atDégouè: The average sizes of the specimens from the floating linevaried from 52 mm (D0) to 77 mm (D36), a variation of 15 mm. In contrast, spat reared on the ground had a linear growth from 62 mm (D0) to 69 mm (D36), i.e. 7 mm (Figure 7). Growth values (K = 0.055 day^{-1} and L∞ = 93.78 mm) are higher for specimens in the floating linethan in the ground rearing (K = 0.047 day^{-1} and L∞ = 84.15 mm). The growth rate in floating line is 1.2 times higher than in the traditional method (Table 1).

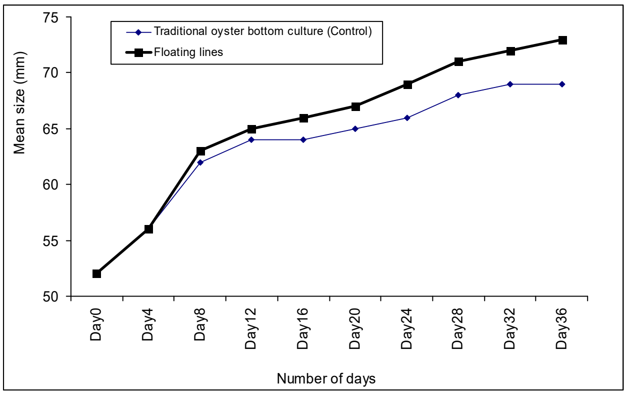

Figure 7. Variations of the mean size of specimens of mangrove oyster *Crassostrea gasar* cultivated with traditional method (bottom culture) and floating lines at Dégouè

DISCUSSION

Oyster culture trials in Africa are meagre. The few available data refer to the traditional culture of the clam *Galatea paradoxa* in Ghana, the cockle *Anadra senilis* in Ghana and Gambia and the mangrove oyster *Crassostrea gasar* in Senegal and Benin (Diadhiou, 1995; Adité *et al.*, 2015; Akélé, 2022). This study aimed to introduce off bottom rearing techniques to improve the production and yield of *Crassostrea gasar* farmed along the coastal lagoon in South Benin. Three techniques, namely vertical suspension culture, horizontal suspension culture and floating line culture, were selected according to the rearing milieu and species life style . Indeed, *C. gasar* is an oyster living in a mesohaline environment, the mangrove (Lapègue *et al.*, 2002). The mangrove oyster lives in its natural state in gregarious formation on stilt roots of mangroves (Lapègue *et al.*, 2002). These plant formations are strongly encountered at the coastal lagoon in Benin and their roots constitute natural supports for the fixation of *Crassostrea gasar* spat (Adité *et al.*, 2013). After 36 days of rearing, the survival rates recorded in the off bottom techniques ((95 to 97.5%) appear to be better compared with that the traditional bottom rearing method where survival rate ranged from 67.5 to 80%. Previous work has shown that the survival of cultivated oysters variedaccording to rearing techniques, the nature of the bottom, the seasons and the biotic and abiotic characteristics of the stations (Adite *et al.*, 2013; Akélé *et al.*, 2017, 2022). The high mortalities recorded in traditional farms can be attributed to the direct contact of oysters with the bottom. Indeed, the bottoms of the rearingstations are sandy-clay and the experimental period (September-October) corresponds to the flooding period of this area. The arrival of rainwater would have loaded the lagoon water with organic particles and grains of sand, thus increasing the risk of mortality of oysters by clogging their gills. The deposition of these materials on the bottom would explain the poor survival of oysters recorded in the traditional technique/ground-based farms. Estimation of the Von Bertalanffy growth parameters (K and L∞) revealed that the best growth performance of oysters was recorded with the new techniques compared to the traditional farms regardless of the station. The values of K amounted to 0.055, 0.154 and 0.055 day^{-1} for the new techniques respectively at Djègbadji (vertical suspension), Sèyigbé (horizontal suspension) and Dégouè (floating line). For traditional oyster farming technique, the growth rate K was 0.054, 0.113 and 0.047 day^{-1} respectively at Djègbadji, Sèyigbé and Dégouè. The values of L∞ evolved in the same direction as the K speed. The best values were obtained with the suspension techniques (respectively 95.35, 65.21 and 93.78 mm at Djègbadji, Sèyigbé and Dégouè) compared to traditional bottom technique (respectively 77.82, 60.024 and 84.15 mm). The best growth performance was recorded at the Sèyigbé station regardless of the rearing technique. Specimens used at Sèyigbé had a lower average initial size (50 mm) than specimens from other sites (≥52 mm).

Knowing that the growth rate of oysters is inversely proportional to their size, the better growth recorded at Sèyigbé can be attributed to the young age of the oysters used at this station.The growth rates recorded in this exprimentation showed the same trend as the Von Bertalanffy growth parameters. Indeed, oysters reared in vertical suspension (GR = 0.36 mm/day, i.e. 10.8 mm/month) at Djègbadji, in horizontal suspension (GR = 0.33 mm/day, i.e. 9.9 mm/month) at Sèyigbé, and in floating line (GR = 0.31 mm/day, i. e. 9.9 mm/month) at Dégouè exhibited growth rates of almost double the rates recorded in traditional farms (4.2, 5.1 and 5.7 mm/month respectively at Djègbadji, Sèyigbé and Dégouè). These values are consistent with the growth rates recorded by Kamara (1982) in Sierra Leone, which were 10 mm/month for *C. tulipa* specimens on farms and 1.04 mm/month on traditional farms. Cham (1988) also recorded a growth rate of 10 mm/month for *C. tulipa* in The Gambia in a suspension culture trial. Thus, suspension culture accelerates the growth of *Crassostrea* oysters. The better growth performance of oysters with the off bottom techniques could be explained by trophic reasons (Adité *et al.*, 2013). The mangrove oyster *Crassostrea gasar* feeds mainly on phytoplankton (about 73% phytoplankton) dominated by diatoms (Adité *et al.*, 2013). A high abundance of phytoplankton at the surface and in the water column, compared to the bottom where photosynthesis is low, would explain this large difference in growth between off bottom and traditional bottom culture techniques. Thus, specimens living in suspension would have access to a higher diversity and density of phytoplankton (Akélé *et al.*, 2022).

CONCLUSION

Suspension culture techniques allow the oysters to grow in the water column where primary production is high. The absence of direct contact of the oysters with the bottom of the water, with suspension culture techniques, reduces the risks of mortality by clogging of the gills and leads to a better survival rate. The exploitation of *C. gasar* being an income generating activity in Benin, the promotion of innovative oyster farming techniques is relevant for the improvement of the grass-roots income. This study indicated promising perspectives for the development of *C. gasar* culture along the coastal lagoon in Benin.

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REFERENCES

Adam, M.E.(1990) Shell growth in some Nile bivalves. J. molluscan Stud. 56 (2), pp. 301-308.

Adité, A., Sonon, S. P., and Gbedjissi, G. L. (2013a) Feeding ecology of the mangrove oyster, *Crassostreagasar* (Dautzenberg, 1891) in traditional farming at the coastal one of Benin, West Africa. Nat. Sci. 5, pp. 1238-1248.

Adité, A., Abou, Y., Sossoukpê, E., and Fiogbé, E. D. (2013b)The oyster farming in the coastal ecosystem of southern Benin (West Africa): environment, growth and contribution to sustainable coastal fisheries management. Int. J. Dev. Res. 3(10), pp. 087-094.

Adjei-Boateng, D., and Wilson, J.G. (2012) Population dynamics of the freshwater clam *Galatea paradoxa* from the Volta River, Ghana. Knowl. Manag. Aquat. 405, pp. 09.

Akélé, G. D., Agadjihouede, H., Mensah, G. A., and Laleye, P. A. (2014)Consumption patterns of freshwater oyster *Etheriaelliptica* (Lamarck, 1807) in the Surrounding Villages of Pendjari Biosphere Reserve : A Potential Substitute Protein source for Bushmeat. Res. j. anim. vet. fisherysci. 2 (10), pp. 1-9.

Akélé, G. D. (2015) Biologie, exploitation et conservation de l'huître d'eau douce *Etheriaelliptica* (Lamarck, 1807) (Mollusca: Bivalvia: Etheriidae) à la rivière Pendjari au Bénin, Thèse de Doctorat en Sciences Agronomiques. Universitéd'Abomey-Calavi, Bénin

Akélé, G. D., AhouansouMontcho, S., and Lalèyè, P. A. (2017) Growth of freshwater oyster*Etheriaelliptica*(Lamarck, 1807) reared in cages in the Pendjari River (Benin, West Africa). Aquat. Living Resour, 30 (17). DOI : 10.1051/alr/2017014

Akélé, D. G., Baglo, I. S., Zannou, M., Montchowui, E., and Lalèyè, P.(2022) Survival and growth of mangrove oyster *Crassostreagasar* (Dautzenberg, 1891) reared at different depths in ponds in Benin (West Africa*).* Int. j. fish. Aquat. Sci. 10(4), pp. 234-243

Anna, E. J.,and Bashir, R. M.(2007) Fishery and culture potentials of the mangrove oyster (*Crassostreagasar*) in Nigeria. Res. J. Biol. Sci. 2(4), pp. 392-394.

Cham, M.A. (1988). Culture of the West African mangrove oyster (*Crassostreatulipa*) in the Gambia. In Aquaculture Systems Research in Africa: proceedings of a workshop held in Bouake, Côte d'Ivoire, pp.14-17. IDRC, Ottawa, ON, CA.

Diadhiou, H. D. (1995) Biologie de l'huître de palétuvier *Crassostreagasar* (Dautzenberg) dans l'estuaire de la Casamance (Sénégal): Reproduction, larves et captage du naissain, Thèse de doctorat en biologie animale. Université de Bretagne Occidentale, Angleterre.

Gilles, S. (1992) Observations sur le captage et la croissance de l'huitre creuse ouest-africaine, *Crassostreagasar*, en Casamance, Sénégal. Ifremer, Actes de Colloques, pp. 14:71-88.

Gulland, J. A.(1969) Manuel des méthodes d'évaluation des stocks d'animaux aquatiques. Manuels FAO de Science Halieutique (FAO) fre, 4.

Kamara, A. B. (1982). Preliminary studies to culture mangrove oysters, *Crassostreatulipa*, in Sierra Leone. Aquaculture. 27(3), pp. 285-294.

Kinkpé, R., Sossa, G.N., andViaho, C. C.(2005).L'ostréiculture traditionnelle: état des lieux et perspectives d'amélioration. Mémoire pour l'obtention du Diplôme d'Etude Agricole Tropicale (Bénin).

Lapègue S., Boutet I., Leitao A., Heurtebise S., Garcia P., Thiriot-Quiévreux C. and Boudry P.(2002) Trans-Atlantic distribution of a mangrove oyster species revealed by 16S mtDNA and karyological analyses. Biol.Bull. 202 (3), pp. 232-242.

Sénouvo, P.(2003). Etude de l'impact des pollutions en métaux lourds (Pb, Cu et Zn) sur l'écologie de l'huître *Crassostreagasar* en zones lagunaires de Cotonou (Bénin) In Livres des résumés. Poissons et pêches Africains: Diversité et utilisation. Troisième Conférence Internationale de l'Association Pana-Africaine des pêches. Cotonou, Bénin, 211 p.14.

Tamburri, M. N., Luckenbach, M.W., Breitburg, D., andBonniwell, S.(2008) Settlement of *Crassostreaariakensis*larvae: effects of substrate, biofilms, sediment and adult chemical cues. J. Shellfish Res. 27(3), pp.601-608.

Von Bertalanffy, L. (1938) A quantitative theory of organic growth (inquiries on growth laws. II). Hum Biol. 10(2), pp. 181-213.

Walfood, L. A. (1946) A new graphic method of describing the growth of animals. Biol. Bull. 90(2), pp.141-147.

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