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Market structure and performance of watermelon (*Citrullus lanatus*) in Benin

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ABSTRACT

Watermelon (*Citrullus lanatus*) is a highly valued fruit of the family of Cucurbitaceae and is cultivated and marketed in Benin for its watery flesh. It is a favorite fruit widely appreciated by many consumers, but few studies have been carried out to understand how its market is structured, how efficient it is and also how far it provides returns to stakeholders in the country. This study aims at evaluating the marketing efficiency of watermelon in Benin and assessing relationships between intermediaries involved in the fruit trade from production to consumption. A survey was conducted and included all the 195 traders registered in Benin during a census in 2015. The results showed that Kaolack and Sugar baby are the most traded cultivars in Benin. The fruit size, the sugar content and the color of the pulp are the main traits that trigger consumers' choice. Four marketing channels were identified: a short one that involves one intermediary and a long one with three intermediaries between the producer and the consumer. The watermelon trade is efficient and provides a net marketing profit of 20 FCFA[1] (0.03 euro)/kg or 70 FCFA (0.11 euro)/fruit for a wholesaler while the retailers earn 50 FCFA (0.08 euro)/kg or 160 FCFA (0.24 euro)/fruit due to the fact that the transaction cost incurred by wholesalers is significant. The average marketing efficiency was estimated at 65%. Retailers are the most efficient with an efficiency rate of 70% while the wholesalers have 50% efficient rate. Nevertheless, only wholesalers earn a significant monthly revenue. We conclude that improving the trade efficiency of watermelon in Benin implies reducing the transaction costs.

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[1] FCFA, officially money of the African financial community is the currency used in Benin. It has a fixed parity with the Euro. A Euro equals 655.957 FCFA.

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Résumé

La pastèque est un fruit à hautes valeurs économiques de la famille des Curcubitaceae. Elle est produite et commercialisée au Bénin pour sa pulpe riche en eau. C'est un fruit très appréciée par la population mais peu d'études ont été menées pour comprendre la structure et le degré d'efficacité de son marché et le niveau de revenus que peuvent obtenir les principaux acteurs. Cette étude vise à évaluer la structure et la performance du marché de la pastèque et à analyser les liens entre les différents acteurs de la commercialisation de la pastèque au Bénin. Pour cela, une enquête a été réalisée sur l'ensemble des 195 commerçants recensés au Bénin en 2015. Les résultats obtenus montrent que "Kaolack" et "Sugar baby" sont les variétés de pastèque les plus échangées au Bénin. La grosseur du fruit, le taux de sucre et la couleur de la chair sont les caractères qui sous-tendent les raisons de choix des consommateurs. L'activité est rentable et procure un bénéfice net de 20 FCFA/kg ou 70 FCFA/fruit chez les grossistes contre 50 FCFA/kg ou 160 FCFA/fruit chez les détaillants car les coûts de transaction supportés par les grossistes sont des plus importants. Le niveau d'efficacité moyen des services rendus par les commerçants est estimé à 65%. Les détaillants sont les plus efficaces avec un taux d'efficacité de 70% contre 50% pour les grossistes. Néanmoins, seuls les grossistes obtiennent un revenu net mensuel important. En conséquence, pour accroître la performance de la commercialisation de la pastèque au Bénin, des efforts doivent être faits pour réduire les coûts de transaction.

Mots clés: Bénin; *Citrullus lanatus*; commerçants, efficacité des services rendus; marché; Pastèque.

Introduction

Watermelon (*Citrullus lanatus* Mansf. & Thumb.) is one of the most important fruits grown in tropical regions. It is highly nutritious for human consumption and provides several nutrients such as lycopene, an antioxidant that prevents cancers and other diseases, potassium, calcium, iron, vitamin A, vitamin C and thiamin ([5,15]). This very perishable fruit is increasingly marketed in some urban and peri–rural areas of Benin.

In Africa, several studies have been carried out on watermelon. Munisse et al. [14] have worked on the diversity of local breeds, agricultural practices and traditional uses of watermelon (*Citrullus lanatus*) in Mozambique. Otunaiya and Adedeji [16] studied the technical efficiency of watermelon production in Nigeria. Adeoye et al. [4] analyzed production systems in Nigeria. Tuffour and Dokurugu [18] and Onyemauwa [15], studied margins and efficiency of watermelon marketing in Ghana and Niger respectively. In Benin only a few studies on the agronomic characterization of the genus *Citrullus* exist [2,3].

We carried out an exploratory study that revealed that watermelon is largely imported from Togo, Burkina-Faso, Mali and Nigeria. Only a small share of the production was attributed to Benin according to retailers. A census of watermelon producers carried out in 2015 by Kpenavoun and Achigan-Dako [11] showed the existence of more than 500 producers and nearly 200 watermelon traders in Benin. No prior studies have been carried out on the producers and watermelon traders in Benin. This research has been initiated to fill the gap by providing information on the structure and efficiency of watermelon market in Benin. This requires an understanding of the relationship among stakeholders working separately to make the product available for the final consumers [7].

Most often market operators negotiate the trading conditions. The payment is made in cash and the delivery is also immediate. The market narrowness, the lack of quality roads in some places, and the irregularity of the production systems make the marketing function more complex and thus show the importance of access to the appropriate information. All marketing activities imply a cost. However, for some locally and regionally traded fruits, questions remain obscure. For instance, what can be the magnitude of exchange costs of watermelon trading? Does the amount paid by the consumer cover the price paid to the producer, plus all the loading costs and transport costs from producers to any intermediaries up to the consumers? Another question is related to the extent of the marketing margin of the watermelon trade in Benin. Sometimes, this margin represents a high percentage and is used as a justification to prove that producers and consumers are exploited. However, these high margins are often fully justified by the increased costs incurred by the consumers. It is impossible to know whether these margins are reasonable or not, if we do not know what these costs represent and how they are calculated. This article provides answers to these queries.

Material and methods

Data collected and used

The census conducted by Kpenavoun and Achigan-Dako [11] provided information on 195 traders of watermelons in Benin, including 51 wholesalers and 144 retailers. Wholesalers are commercial intermediaries who sell watermelons to retailers and are rarely connected with consumers while retailers are considered to be commercial intermediaries selling the watermelons to consumers. The data used in this study was collected from a quantitative survey carried out in 2015 and it included all the 195 traders listed during the 2015 census. However, at the end of a census of a given population, it is impossible to say that all units of this population have been identified. Therefore, we accepted the census with a tolerable margin error level. With possible census errors, this set of producers can be considered as a representative sample of the population of watermelon traders in Benin.

Data were collected through structured interviews using a questionnaire. Data collected included: socio-demographic characteristics of traders, the quantities of watermelon purchased during a month, the varieties marketed, the buying and selling markets, the total amount of sales of watermelons purchased, the human resources involved in the transactions, the type of transport used, the working time, the various costs supported by the trader, the buying and selling prices of each unit of watermelon, types of intermediaries, commercialization channels, types of markets, number of stakeholders, tools and quality's standard, physical infrastructures, regulation to enter the markets, legal institutions and the playing rules. Data were collected in order to characterize the different types of markets attended by traders. We further decided in 2017 to visit all traders surveyed in 2015 in order to ask them the following useful questions to understand the results obtained: (1) What are the access conditions of markets that you visited? (2) What are the periods of abundance and scarcity of watermelon? (3) Do you think you can live decently by selling watermelon only?

Data analysis

Data were analyzed using descriptive statistics that allowed us to make a fair characterization of watermelon marketing system in the country.

Economic parameters were computed to assess the level of performance of the watermelon market. These are the marketing margin, the efficiency of the marketing system of watermelon, the estimated net income of the trader and the net marketing profit.

In this study, the marketing margin is defined as the difference between the selling price and the purchase price.

The price changes with time. So to get a good idea of the average prices of buying and selling watermelon, we surveyed the traders for a month. During that month, we recorded the quantities of watermelon fruits that were purchased and sold as well as the total amount of the month's purchases and sales.

Under these conditions, the sale price is obtained by dividing the total monthly sales of watermelon by the number of fruits sold in the month. The purchase price is obtained by dividing the total monthly purchase amount of the watermelon fruit by the number of fruits purchased in the month. In this study, the number of fruits purchased is equal to the number of fruits sold in a month from a closer follow-up of traders' transactions.

The real marketing cost is the sum of the transport cost, storage cost, handling cost, the costs associated with the loads and unloads, the rental costs of the place of sale, the taxes, and the depreciation values of rolling stock.

The estimated trader net income is the difference between the marketing margin and the real marketing costs. In fact, traders do not pay themselves a salary, so this data was not available. However, information on their salary intention was obtained and the contribution of watermelon trade into their revenue was calculated. This allowed determination of the total cost of watermelon marketing which is equal to the effective cost of marketing plus the expected revenue of the trader.

The efficiency of the marketing system of watermelon is estimated with the following formula:

$$\text{Efficiency } = 100 - \left(\frac{\text{marketing cost}}{\text{marketing margin}} * \times 100 \right)$$

In a market where competition prevails, a positive value of this parameter would justify application of marketing services, making it efficient, and a negative estimate will indicate otherwise [1]. The higher this index, the more efficient the stakeholder is in the watermelon market.

In this study, the marketing margin, the real marketing costs, the trader's net income and the net marketing profit obtained from the sale of the watermelon fruit were calculated for one watermelon fruit and for one kg of watermelon.

The trader's net income is supported by the work he/she provided by transporting the fruit from the producer to the consumers. The monthly net income from the sale of fruit and the possible monthly income from all of the trader's activities were also estimated. However, all surveyed traders were not solely specialized in watermelon sale. They also sell other fruits and sometimes deal with other activities. Thus, the total revenue from all the trader's activities was calculated taking into account the marketing margin from the watermelon selling and the percentage of the watermelon trade among other activities dealt by the trader.

On the watermelon market the main actors we encountered were the wholesalers and the retailers. The different economic parameters were calculated for each type of these stakeholders.

Descriptive statistics such as means and standard deviations were calculated for each of the quantitative variables followed by the Student *t*-test or the Kruskal–Wallis test (when convenient) to compare the results obtained between retailers and wholesalers. In terms of qualitative variables, absolute percentages and frequencies were determined followed by the chi-squared test. Before carrying out the appropriate Student *t*-test with the Stata software, the normality of each of the quantitative variables was tested. In the event that the normality of a variable was not rejected at the 5% threshold, the Bartlett test was performed to verify whether or not the variances of the quantitative variables considered were equal. In the case where the normality of the variables was rejected at the threshold of 5%, the test of Kruskal–Wallis was used. Kruskal–Wallis test is equivalent to the Mann–Whitney test when the number of groups is equal to 2.

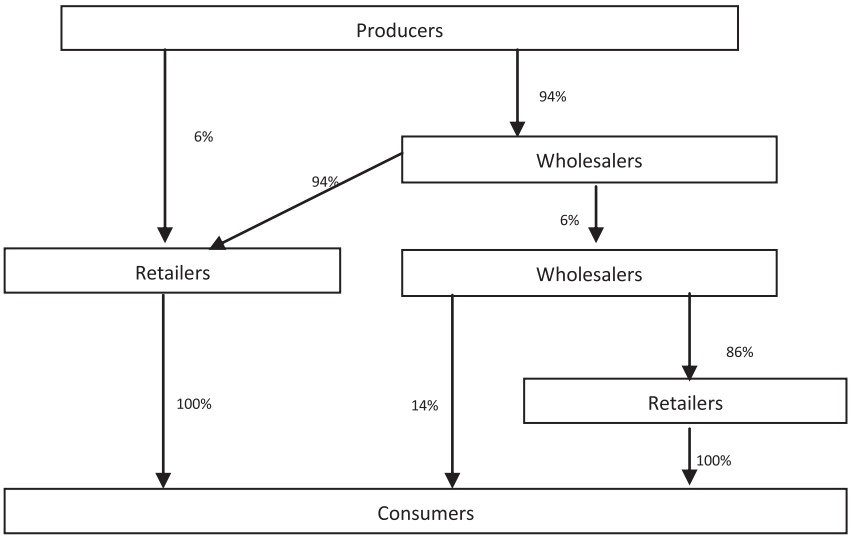

Fig. 1. Actors of the marketing channel of watermelon in Benin.
Source: Source: Data collected from our quantitative survey 2015.

Results and discussion

Market structure

According to Clodius and Mueller [6], the market structure is linked to the market organization's characteristics that seem to influence the nature of the competition between market actors and also influence the process of the market price fixing. It is about the characteristics that are fixed for the short term for each stakeholder. The market structure includes the trade's channels that are used for commercializing the fruits and the legal institutions that set the rules for market users.

According to Lutz [12], the market structure's components are as follows: types of intermediaries, commercialization channels, types of markets, number of stakeholders, tools and quality's standard, physical infrastructures, regulation to enter the markets, legal institutions and the playing rules. The stakeholders' organizational environment of a commodity is set around activities and interventions of each stakeholder. We found four main stakeholders involved in watermelon trade in Benin: producers, retailers, wholesalers and the consumers.

Producers stand at the first level alongside the marketing system. Their role consists of providing sufficient quantities of food to fit the requested quantity. They sell their commodities either in field or on the first commercialization market. The census carried out by Kpenavoun and Achigan-Dako [11] made it possible to count 506 producers of watermelon. The majority (98%) of the producers are men. Producers sell watermelon fruits primarily to wholesalers (94%) and secondarily to retailers (6%) (Fig. 1).

Wholesalers are the traders who purchase and sell the commodity in high quantity. They purchase the product from producers and/or from other wholesalers who come from Burkina Faso or Togo. Wholesalers represent 26% of surveyed traders in our study (Table 1). They transport fruits from buying markets to the selling markets where they sell to other wholesalers (6%) and to retailers (94%). Only some wholesalers (14%), who purchase the fruits from other wholesalers, come to the watermelon trading market to sell their fruit to the consumers (Fig. 1).

Retailers are traders who purchase by retail and sell also by retail. Retailers can operate from the producer's environment. Some of them purchase the products from the producers. But majority of the retailers purchase the fruits from the wholesalers. They represent 74% of the surveyed traders during this study. Retailers sell their products directly to the consumers.

Retailers and wholesalers are the two main types of intermediaries known on the watermelon market in Benin. Table 1 showed that the marketing of watermelon is mainly a female activity with 95% of traders being women. However, men are much more represented than women among wholesalers at the 5% threshold ($P = 0.078$). This observation was also made by Onyemauwa [15] and Kainga [9] in Nigeria.

Age does not differentiate retailers and wholesalers at the 5% threshold ($P = 0.536$). Watermelon traders are more or less young because they are on average aged 38 years and have an average work experience of 12 years. This indicates that these traders are active, agile and experienced. Half (52%) of traders, or 53% of retailers and 49% of wholesalers, were not formally educated. Similarly, among the educated traders, 66% have only primary school level education. The education level of watermelon traders is therefore relatively low and is the same for retailers and the wholesalers at the 5% threshold ($P = 0.295$). This result supports the findings of Tuffour and Dokurugu [18] who revealed that the level of education of agri-

Table 1
Descriptive statistics of watermelon traders (n = 195).

Variable	Retailer	Wholesaler	All traders	Significance
Number of observations	74% (144)	26% (51)	100% (195)	–
Qualitative variable				chi-square test *P*-value
Market				
Primary market	6% (8)	24% (12)	10% (20)	0.000***
Urban market	94% (136)	76% (39)	90% (175)	
Sex				
Female	97% (139)	90% (46)	95% (185)	0.078*
Male	3% (5)	10% (5)	5% (10)	
Education Level				
No formal level of education	53% (77)	49% (25)	52% (102)	0.295
Primary level	28% (41)	39% (20)	31% (61)	
Secondary or university level	18% (26)	12% (6)	17% (32)	
Marital status				
Single	3% (5)	2% (1)	3% (6)	0.413
Married	94% (135)	98% (50)	95% (185)	
Widower	3% (4)	0% (0)	2% (4)	
Cultivar of watermelon preferred by consumers				
Kaolack	100% (144)	100% (51)	100% (195)	–
Sugar baby	82% (118)	84% (43)	83% (161)	0.702
Charleston grey	15% (21)	24% (12)	17% (33)	0.143
Market information system				
Visit to the buying market	99% (142)	84% (43)	95% (185)	0.000***
Phone	15% (22)	24% (12)	17% (34)	0.182
Use and source of credit				
Use of credit	15% (22)	29% (15)	19% (37)	0.027**
Micro-finance structures	50% (11)	60% (9)	54% (20)	0.549
Personal networks	55% (12)	47% (7)	51% (19)	0.638
Use of own capital only and reasons for non-access to credit				
Use of own capital only as a source of financing	85% (122)	71% (36)	81% (158)	0.027**
Do not need credit	3% (4)	8% (3)	4% (7)	0.195
Do not like credit	69% (84)	64% (23)	68% (107)	0.576
Complicated approach	18% (22)	19% (7)	18% (29)	0.848
High interest rate	11% (14)	3% (1)	9% (15)	0.118
No guarantees required	4% (5)	11% (4)	6% (9)	0.111
Quantitative variable (average) with Student *t*-test or Kruskal–Wallis test				
Age	37 (8)	38 (9)	38 (11)	0.536
Number of years of experience	11 (8)	11 (7)	11 (8)	0.851

The number in brackets is the absolute frequency for the qualitative variables and the standard deviation for the quantitative variables. ***, ** and * means that the test performed is significant at 1%, 5% and 10% respectively.

cultural traders continues to be low in rural areas of Africa. These actors belong to different socio-cultural groups creating diversity and wealth of relationships. Also, 95% of traders are married with family and financial responsibilities.

Consumers represent the last stakeholders in the marketing chain. The marketing purpose is to satisfy the demand expressed by those stakeholders. The most sold watermelon cultivars in Benin are: Kaolack, Sugar Baby and Charleston grey. Kaolack cultivar is sold by all traders. It is the most preferred cultivar by all consumers. Charleston grey cultivar was the less preferred cultivar. The size of the fruit, the sugar content and the color of the pulp were the major fruit traits that guide the choice made by consumers.

Different stakeholders on the marketing chain maintain more or less complex relationships between themselves that are characterized by the commodity exchange, exchange of money and information. Fig. 1 contains different marketing channels that were described. The shortest channel has one intermediary and the longest channel has three intermediaries. From Fig. 1, different marketing channels of watermelon trade can be defined as follows. (1) marketing channel 1 from producers to consumers through retailers; (2) marketing channel 2 from producers to consumers through two types of wholesalers and retailers; (3) marketing channel 3 from producers to consumers through two types of wholesalers; (4) marketing channel 4 from producers to consumers through wholesalers and retailers.

Marketing channel 1 is the shortest marketing channel of watermelon while marketing channel 2 is the longest. The watermelon markets where those stakeholders operate are classified taking into account the markets' locations, the types of stakeholders and the markets' periodicity. There are two types of markets: the primary markets and the urban markets.

Primary markets are specific areas of business transactions located in the localities of production. Producers bring their products to sell to wholesalers and retailers. These markets often take place every five days. The primary markets identified

included those of Sompérékou, Ina, N'Dali, Kandi, located in northern Benin and those of Togba, Aïtchédji, Akassato, Pahou, Cococodji, Cocotomey, Kpassè, in the south of Benin.

Urban markets are located in the large urban areas that are generally far from the production areas and are better equipped with transport infrastructures. Those markets take place daily although sometimes a certain day is unanimously recognized as the weekly market day. They are characterized by wholesale and retail trade transactions and the presence of all stakeholders. In addition, there are some traders who have settled alongside rural or urban roads to sell watermelon fruit.

A few traders have rudimentary building in the formal markets. Under these conditions, they pay monthly taxes to the market management enterprise (Société de Gestion des Marchés: SOGEMA) or to administrative local authorities or to other public administrative authorities. Trading access into these markets is not free and requires prior authorization from the market management authorities.

Table 1 indicates that 90% of surveyed traders operate in urban markets to create added value for watermelon fruit. They buy fruit in retail, in quarantine, with car or truck and sell either as fruit units or as a bulk of 40 fruits locally known as 'quarantaine'.

Market behavior

The market behavior is related to the patterns of behavior presented by the traders in order to conform themselves to the conditions of markets where they sell or purchase. These are the strategies used by the stakeholders who operate in the market. These strategies depend on the market structure and the individual power of the trader in the market. The components that determine the market behavior are as follow: transport, storage, information on purchases and sales conditions, and financing.

A low number of traders (5%) have their own car to transport the watermelon fruits from the place of purchase to the point of sale. The majority of traders rent cars with 6–9 seats, sheeted cars, minibuses or motorcycles. Most traders use rickshaws to transport watermelon fruits to the place of sale. The transport means used by traders depend on the type of trader, the quantity of watermelon fruits purchased, the size of the fruits and the distance between the sales and purchasing markets.

Currently few roads are asphalted in Benin, making watermelon fruits transport very difficult. For instance, in 2016, 2684.82 km of roads were asphalted but only 17.2% of them are useful due to the insufficiency of the maintenance [13]. The Government's Policy Program aims to rehabilitate, modernize and extend the national road network to 1300 km by 2021 [17]. This poses a challenge for producers to link the production area to the urban markets where watermelon fruit is abundantly sold.

In the markets, the majority of wholesalers rent a shop to store their commodities, but retailers that do not own a shop store on their marketing place under the hangars or use rickshaws every day to move their products from the home to the place of sale. Some wholesalers own a guard.

Between the stakeholders the information circulates throughout the marketing chain using some communication tools. The most widely used source of information by majority of traders (95%) is the physical visit to the purchase market as shown in Table 1. Physical visit means that the trader must go to the market in order to access information. This source of market information is mostly used by retailers at the 1% threshold ($P = 0.000$). The reliability of the information exchanged depends on the common interests and the relationship between the actors. The implication is that the more the common interests, the greater the reliability of exchanged information. To verify the information, some traders ask their friends-parents and/or other traders to triangulate the news received. These strategies allow traders to have an idea on the price of the last market day and to set prices (ceiling and floor) for the next market day but this increases the transaction costs [10].

Table 1 showed that the use of mobile phones as a tool of communication does not yet play an important role in the watermelon market. Indeed, 96% of traders and 84% of producers have a mobile phone, but only 17% of traders use it to access market information.

Table 1 indicates that most traders (81%) finance their own business. This result showed that despite the existence of microfinance structures, watermelon traders have limited access to credit to finance their activities. Various reasons are declared by traders to explain their weak access to credits, 68% of traders interviewed do not like the use of credit and 18% find the process complicated (Table 1).

Market performance

According to Harris [8], market performance expresses the economic results gained by all market stakeholders. It reflects the economic result of the market structure and the behavior of the market stakeholders. It focuses on the relationships between the marketing margins and the marketing costs. The performance of the market in this paper is measured by the marketing margin, the marketing efficiency, the net income derived from the sale of watermelon fruits and the net profit.

The duration of the purchase and the frequency of the supply of watermelon fruits vary from one type of trader to another. Therefore, the economic parameters are computed over one-month cycle during the watermelon scarcity period and are expressed in FCFA. The period of scarcity is the most relevant period to know the effective watermelon fruits vendors.

Table 2
Economic parameters of retailers and wholesalers per kg and per unit of watermelon fruit in times of scarcity.

Indicator	Retailer	Wholesaler	All traders	*P*-value (Student *t*-test or Kruskal–Wallis)
Monthly supply frequency	4	3	4	0.182
Purchase price (FCFA/kg)	160 (81)	140 (69)	150 (78)	0.199
Purchase price (fruit)	540 (279)	480 (236)	520 (269)	
Sale price (FCFA/kg)	225 (111)	190 (85)	220 (105)	0.042**
Sale price (FCFA/fruit)	770 (380)	665 (292)	740 (362)	
Marketing margin (FCFA/kg)	70 (52)	50 (32)	60 (48)	0.028**
Marketing margin (FCFA/fruit)	230 (177)	180 (110)	220 (163)	
Real marketing cost (FCFA/kg)	15 (12)	25 (29)	20 (18)	0.003***
Real marketing cost (FCFA/fruit)	50 (41)	85 (99)	60 (63)	
Total marketing cost (FCFA/kg)	20 (14)	30 (34)	25 (22)	0.007***
Total marketing cost (FCFA/fruit)	70 (49)	110 (117)	80 (75)	
Net marketing profit (FCFA/kg)	50 (51)	20 (36)	40 (49)	0.001***
Net marketing profit (FCFA/fruit)	160 (175)	70 (122)	140 (167)	
Trader's net income (FCFA/kg)	50 (52)	30 (31)	50 (49)	0.001***
Trader's net income (FCFA/fruit)	180 (178)	100 (108)	160 (166)	
Marketing efficiency (%)	70 (30)	50 (39)	65 (34)	0.000***

1 Euro = 655,957 FCFA. The number in brackets is the standard deviation. ***, ** and * means that the test performed is significant at 1%, 5% and 10% respectively.

Table 3
Economic parameters of retailers and wholesalers per month in times of scarcity.

Indicator	Retailer	Wholesaler	All traders	*P*-value (Kruskal–Wallis test)
Purchase amount (FCFA)	63,780 (73,300)	709,430 (1,572,159)	232,650 (849,658)	0.000***
Sales amount (FCFA)	89,825 (104,115)	903,400 (1,972,621)	302,605 (1,067,418)	0.000***
Marketing margin (FCFA)	26,040 (37,888)	193,965 (408,919)	69,960 (222,775)	0.000***
Real marketing cost (FCFA)	4310 (7578)	43,180 (51,362)	14,480 (31,867)	0.000***
Total marketing cost (FCFA)	9220 (8406)	65,275 (53,700)	23,880 (37,486)	0.000***
Net marketing profit (FCFA)	16,820 (36,912)	128,690 (380,472)	46,080 (201,849)	0.003***
Net income (FCFA)	21,730 (36,940)	150,790 (379,702)	55,480 (203,464)	0.000***

The number in brackets is the standard deviation. ***, ** and * means that the test performed is significant at 1%, 5% and 10% respectively.

Table 2 presents the results of the computation of the different economic parameters per kilogram and per unit of watermelon fruit sold in times of scarcity and Table 3 presents the monthly results of these parameters.

Table 2 showed that there is no significant difference between the average monthly supply frequency of retailers and wholesalers at the 5% threshold ($P = 0.182$). The average purchase price is 150 FCFA/kg or 520 FCFA/fruit while the average selling price is 220 FCFA/kg or 740 FCFA/fruit. The purchase prices do not vary with regards to the type of trader at the 5% threshold ($P = 0.199$) but retailers' selling price is higher than that of wholesalers at the 5% threshold ($P = 0.042$). Then, there is a marketing margin of 50 FCFA/kg or 180 FCFA/fruit for wholesalers and 70 FCFA/kg and 230 FCFA/fruit for retailers.

Taking into account the high quantity of watermelon fruits exchanged by the wholesalers, their monthly purchase and selling price are ten to eleven times higher than that of the retailers (Table 3). Their monthly marketing margins are at least seven times higher than that of the retailers (Table 3). For the retailers, the monthly marketing margin is 26,040 FCFA/month, and for the wholesalers it is 193,965 FCFA/month. However, the marketing margins for traders in Benin are often less than that of Ghanaian traders [18]. In fact, the Ghanaian wholesalers earn 13,030 GHc/month (1,522,690 FCFA/month) and the retailers 472 GHc/month (5160 FCFA/month) as monthly marketing margin.

The real cost of watermelon marketing is estimated at 20 FCFA/kg or 60 FCFA/fruit. Wholesalers have a real unit cost of marketing higher than that of retailers at the 1% threshold ($P = 0.003$). In one month, wholesalers bear a real marketing cost of 43,180 FCFA which are 10 times greater than that of retailers (Table 3). The total cost of marketing which takes into account all the real and calculated charges (including the remuneration of the trader's work) is in average of 25 FCFA/kg or 80 FCFA/fruit for all traders (Table 2), or 23,880 FCFA/month (Table 3).

Due to the high marketing unit cost endorsed by the wholesalers, the net income and the unit net earning they get are less than that of the retailers. Wholesalers have a real unit cost of marketing that is higher than that of retailers ($P = 0.001$). The selling margin for all the traders is estimated at 50 FCFA/kg or 160 FCFA/fruit (55,480 FCFA/month).

However, the monthly net income of wholesalers (150,790 FCFA) is significantly higher than that of retailers (21,730 FCFA) ($P < 0.001$). This shows that wholesalers earn from the amount of watermelon sold and not from the unit of the sold fruit. It should be noted that retailers have a monthly net income below the Guaranteed Minimum Interprofessional Wage (SMIG) in Benin, which is 40,000 FCFA. So, they do sell other fruits or vegetables that generate income apart from what they earn monthly from watermelon selling.

The net marketing profit obtained after deduction of the total production costs is positive and estimated at 40 FCFA/kg or 140 FCFA/fruit or 46,080 FCFA/month. The marketing of watermelon in Benin is therefore a profitable activity for all traders.

Retailers have a higher net marketing profit per unit than wholesalers at the 1% threshold ($P = 0.001$). In fact, wholesalers are intermediaries who go to the high fare market to purchase the fruits and then face high transaction costs. The degradation of the roads leading to the farms is a factor that increases transportation costs. Thus, the government must invest in rehabilitating and maintaining rural roads in order to facilitate the transport of agricultural products from production areas to the urban markets. This would allow the wholesalers' transaction costs to be reduced and consequently the purchase price of the watermelon fruit can be reduced for the final consumer.

Moreover, overall, watermelon traders are efficient with an average efficiency estimated at 65%. The retailers have an efficiency rate of 70%, significantly higher ($P = 0.000$) than that of wholesalers which is 50%. This shows that retailers are more efficient than wholesalers in the watermelon marketing in Benin. These results are consistent with those obtained by Tuffour and Dokurugu [18]. However, the level of efficiency of Beninese watermelon traders is much lower than that of watermelon traders in northern Ghana. The efficiency level is 79.93% for wholesalers and 89.83% for retailers in Ghana.

Other authors have obtained lower efficiency indices than those obtained in Benin. For instance, the traders of watermelon in Yenagoa metropolis of Bayelsa State in Niger Delta Area of Nigeria have marketing efficiency of 58.8% [9].

Conclusion

The present work has enabled us on the one hand to understand the structure of the watermelon markets in Benin and on the other hand to analyze the marketing efficiency.

The results obtained showed that the marketing of watermelon is mainly a female activity with 95% of female traders. Watermelon fruit in Benin comes not only from the fields of the local producers but also from neighboring countries such as Niger, Burkina-Faso and Togo. Retailers are the most numerous marketing intermediaries in the watermelon market in Benin. Wholesalers are only 26% of these traders. Half (52%) of traders, or 53% of retailers and 49% of wholesalers, are not formally educated. Similarly, among the formal educated traders, 66% had only the primary school education level. The education level of watermelon traders is therefore relatively low.

The most traded watermelon cultivars in Benin are: Kaolack, Sugar Baby and Charleston Grey. Kaolack is the most sold cultivar by all traders and therefore the most demanded by consumers. The size of the fruit, the rate of sugar and the color of the pulp are the fruits traits that guide the choice of the consumers.

The means of transport used depend upon the type of trader, the quantity of watermelon purchased, the size of the watermelon and the distance between the sales markets and the purchasing markets. Some traders (5%) have a car to transport watermelon. The majority of wholesalers use rented cars while most retailers operate with taxi-motorcycles and rickshaws to transport watermelon fruit to the place of sale.

Most traders do not deal with credits for their business. They believe that access to credit is complex and the interest rate offered is high.

Almost all traders (96%) have mobile phones but only 17% use them to access market information. The physical market visit is the most used and costly means of accessing information. Four marketing channels have been identified with the shortest having one intermediary and the longest with three intermediaries between the producer and the consumer.

Financial and economic analysis has shown that watermelon marketing is a profitable activity for all traders. The net marketing profit is 20 FCFA/kg and 70 FCFA/fruit for wholesalers and 50 FCFA/kg and 160 FCFA/fruit for retailers. This shows that retailers earn more on the watermelon unit sold than wholesalers. The monthly net income from marketing activity is 21,730 FCFA for retailers and 150,790 FCFA among wholesalers. The monthly net income of retailers remains lower as compared to the SMIG in Benin. Therefore, no retailer can live above the poverty limit by only watermelon trade. However, the efficiency analysis showed that retailers are more efficient (70%) than wholesalers (50%).

In order to improve the economic performance of watermelon traders in Benin, efforts should be made to reduce transaction costs.

Conflict of interest

The authors declare that they have no conflict of interest.

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Supplementary material

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