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Knowledge and practices of vegetable consumption in Accra and greater Lomé: nutritional, health and environmental sustainability

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Abstract: In Accra and Greater Lomé, research into the harmful effects of food transitions focuses scarcely on the levels of knowledge and good practices (LKGP) of vegetable consumers. However, these foods play a key role in the nutritional, health, socio-economic and ecological sustainability of cities. This research aims to assess the health, nutritional, ecological and socio-economic sustainability of LKGP linked to vegetable consumption in these conurbations. A quantified multi-criteria evaluation approach was adopted. The respondents (394), selected via judgmental sampling, were equally distributed between the two cities. Data were collected using a Food Frequency Questionnaire administered by Kobocollect. The overall average rate of good vegetable consumption knowledge and practices in Accra and Greater Lomé is low (37.43%). This result stems from the low LKGP for daily vegetable consumption (24.62%), their inclusion in the main daily meals (33.50%) and consideration of their nutritional composition (30.86%). The target population is unaware of the health, nutritional and ecological drawbacks of poorly preserved vegetables (66.93%) and adopts inappropriate waste management practices when handling them (65.91%). The average proportions of access to vegetable procurement technology (47.08%) and sustainable food education (11.29%) were also low. The research results, unfavorable to the achievement of the SDGs in Accra and Greater Lomé, call for an inclusive, integrated and continuous sustainable food education program.

Keywords: *Eco-nutritional culture; Food and nutrition education, Health and socio-economic risks, Urban food sustainability, Vegetable consumption.*

1. Introduction

Since the two first decades of the 21st century, urban food systems have been changing dramatically around the world, in both northern and southern countries (K.D. Bissadu and al., 2024; J. Tefft and M. Jonasova, 2020). These changes affect several food chains, including vegetables produced in Accra and Greater Lomé, the respective capitals of Ghana and Togo (J. Harris and al., 2022). In the Accra Metropolitan Assembly (AMA) and the Autonomous District of Greater Lomé (DAGL), these mutations influence the production, marketing, processing, transport, packaging, preservation, storage and consumption of food, particularly those of the vegetable sector (C. de Steenhuijsen Piters and al., 2021, p. 75-79; J. Quansah and al., 2020). At the expense of "home cooking" and more reassuring family meals in terms of vegetable consumption, eating outside has become widespread (S.E. Hiamey and G.A. Hiamey, 2018; K. Kpotchou, 2017). The same applies to the high consumption of imported foods of dubious origin, processed and high sugar content, the destructuring of food days and e-food (A. Adams and al., 2023; K. Soncy and al., 2019; J. Staatz and F. Hollinger, 2016). This has led to significant growth in the rates of patients with diabetes, blood pressure disorders, cancers, arthritis, hematological

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pathologies, etc. (K.C. Kouassi, 2021; T. Reardon and al., 2021; K. Soncy and al., 2019). This food modernity and its deleterious health, economic and ecological consequences highlight a worrying trend in malnutrition and undernourishment among the inhabitants of these cities (E. Afriyie and al., 2022; M.I. Dzudzor and al., 2024; C. Tuholske and al., 2020). The high proportions of nutritional deficiencies observed in sub-Saharan Africa do not spare the aforementioned cities. These nutritional gaps are often explained by a low intake of vitamins, minerals and other nutrient compounds conducive to healthy, active eating (K. Noopur and al., 2023, p. 22; P. Schreinemachers and al., 2021, p. 4; B. Stadlmayr and al., 2023). As in most sub-Saharan African countries, this can be explained by the fact that vegetable consumption is significantly lower than the daily quantities recommended by FAO experts (B. de Steenhuijsen Piters and al., 2021, p. 25-26; Y. Dijkxhoorn and al., 2021, p. 3; A.W. Ebert, 2020, p. 3).

Faced with these challenges of food, nutritional and ecological sustainability, public and civil society stakeholders in Ghana and Togo are working to promote food and nutritional security. Numerous projects and programs have been implemented as part of policies aimed at making these countries' agri-food systems more sustainable (J. Ainuson-Quampah and al., 2022; R.A. Annan and al., 2022; R. Aryeetey and J.B. Coomson, 2022; A. Laar and al., 2020; H.A. Osei-Kwasi and al., 2021; C.D. Tomta-Heinrich, 2020). Ghana's first city has adopted a by-law specifically implementing the country's food safety and hygiene policy. This regulation takes into account environmental protection, nutrition, hygiene and the general well-being of consumers and even producers, but its application faces obstacles (V. Linderhof and al., 2019, p. 2). In Accra, actions to strengthen the resilience of food systems to shocks have focused more on modernizing agriculture in order to increase the city's production capacity by popularizing modern production techniques accessible to producers of all categories and optimizing the reduction of food losses and waste along the city's supply chains (AMA, 2020, p. 25). V. Linderhof and al. (2023, p. 29-30) have advocated an approach to what Accra's food system should look like in 2050, and transition paths to get there. These transition paths are generally based on the introduction of food practices and lifestyles based on endogenous know-how, as well as on the production, processing and green consumption of foodstuffs that are permanently available and accessible to all (V. Linderhof and al., 2023, p. 24-29). In Greater Lomé, Togo's national food and nutrition security policies are embedded in urban areas through the Transition of Agricultural and Food Systems on Territories (TERSAA) program. TERSAA's overall aim is to make food systems sustainable and resilient in the communes of the Plateaux and Kara regions, particularly at the post-productive stage. More specifically, it seeks to facilitate access by targeted consumers to quality, locally produced food. The project is based on professionalization, sustainable and equitable partnerships, and linking family farming to local markets.

However, whether in the Accra metropolitan district or in the DAGL, the vegetable value chain is less of a priority in the above-mentioned projects and programs than that of staple foods such as cereals, tubers and legumes. For G. Grubben and al. (2014, p. 24-25), many political actors, in the realization of their visions, give less priority to the nutritional and economic value of vegetables; nevertheless, the population explosion in these urban centers can make the demand for them more important and create a problem of accessibility. According to B. de Steenhuijsen Piters and al. (2021, p. 22-23) and S. Imathiu (2021, p. 118-120), more than cereals, vegetables are scientifically recognized as possessing remarkable levels of protein. Very rich in carbohydrates, proteins and fiber, they can promote the absorption of vitamins (A, C, B2, etc.) and minerals (zinc, iron, calcium, etc.). They can also help prevent certain types of cancer, diabetes, obesity, etc., and even promote socio-economic development and environmental protection by reducing soil degradation and water pollution (S. Imathiu, 2021, p. 120; C. Ojiewo and al., 2015; J.A.M. Pereira and al., 2022; K.V. Peter and al., 2021). The FAO recommends a daily consumption of 240g combined with 140g of fruit (B. de Steenhuijsen Piters and al., 2021, p. 22-24; G. Grubben and al., 2014, p. 24-25).

Although one of the key messages promoting healthy eating within these cities exhorts their residents to “eat five fruits and vegetables a day”, it remains to be seen whether this phrase holds any

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significance in their food and nutrition culture. Even in the existing scientific literature, the finding is the same. Research into the knowledge, attitudes and practices of "eating out" in Lomé and Accra has not focused in any significant way on analyses linked to the level of awareness of the inhabitants of these cities of the nutritional importance of vegetables and the public health and socio-economic risks associated with their under-consumption. These studies have focused more on hygienic practices, symbolic mutations and the permanence of food, the risks of contamination and intoxication, food fears, and the adoption of new supply and preparation technologies, with an interest in the representations, socialities and sociabilities involved (K.E. Assinou, 2020; K. Kpotchou, 2017, 2018a, 2018b, 2021). To state the obvious, despite the micronutrient and macronutrient requirements of vegetables for a healthy and active human life, they have not been the subject of any particular attention in the implementation of projects or programs to make food systems more viable in the capital cities of Ghana and Togo. Nor have they aroused any particular interest in the existing literature on the agrifood knowledge and practices of Loméans and people living in Accra. However, research into the health, nutritional and ecological benefits linked to levels of knowledge and good vegetable consumption practices among city dwellers in the first cities of Ghana and Togo would provide an important source of data for the design and implementation of projects and programs aimed at making the food systems of these cities more sustainable.

This leads to the following question: are knowledge levels and good vegetable consumption practices among Lomé and Accra consumers favorable to a nutritious, healthy, sufficient and ecological diet? The hypothesis associated with this question is as follows: the low levels of knowledge and good practices among the inhabitants of Accra and Greater Lomé about the nutritional constitution and dietary benefits of vegetables constitute a major obstacle to the health, ecological and socio-economic sustainability of these cities. In doing so, this research aims to assess the health, nutritional, ecological and socio-economic sustainability of the levels of knowledge and good food practices relating to vegetable handling among Loméans and people living in Accra.

2. Materials and Methods

2.1. Physical Research Environment

The comparative assessment of knowledge levels and good practices relating to the nutritional, health and ecological sustainability of vegetable consumption concerns the territories of the Accra Metropolitan Assembly (AMA) and the Greater Lomé Autonomous District (DAGL). AMA and DAGL are respectively the largest urban centers in Ghana and Togo. The AMA is located in the Greater Accra region of Ghana and is the country's capital. DAGL is the capital of Togo. Ghana's first city covers 139, 67 Km2 while Togo's has an area of 425.6 Km2 (GSS, 2014, p. 1; INSEED, 2022, p. 19, 22-30). These territories concentrate the main administrative, political and economic functions of Ghana and Togo (R.A. Acheampong, 2021, p. 69, 77-79; K.A. Biakouye, 2014; T.-H. Blakime and al., 2024, p. 1-3; GSS, 2014, p. 3-4). The AMA's northern boundary is the "Ga West Municipal"; the "Ga South Municipal" lies at the city's far western end, while "La Dadekotopon Municipal" and the Gulf of Guinea lie at its southern and eastern ends respectively. The DAGL is bordered by the Zio prefecture to the north, Ghana to the west, the Lacs prefecture to the east and the Gulf of Guinea to the south. Twelve (12) districts make up the AMA, while the (DAGL) is; a grouping of 13 communes defined as a specific territorial entity with legal personality and financial autonomy, whose territorial jurisdictions, attributions and functioning are defined by Decree No. 2017-131/PR of November 15, 2017 in Togo. Around two million seven hundred and sixty-seven thousand four hundred and sixteen (2,767,416) people live in the DAGL and one million two hundred and eighty-one thousand five hundred and seventy (1,281,570) men and women live in the AMA (GSS, 2021, p. 19; INSEED, 2022).

The figure complex below shows the various localities considered in the analysis, including the data collection sites.

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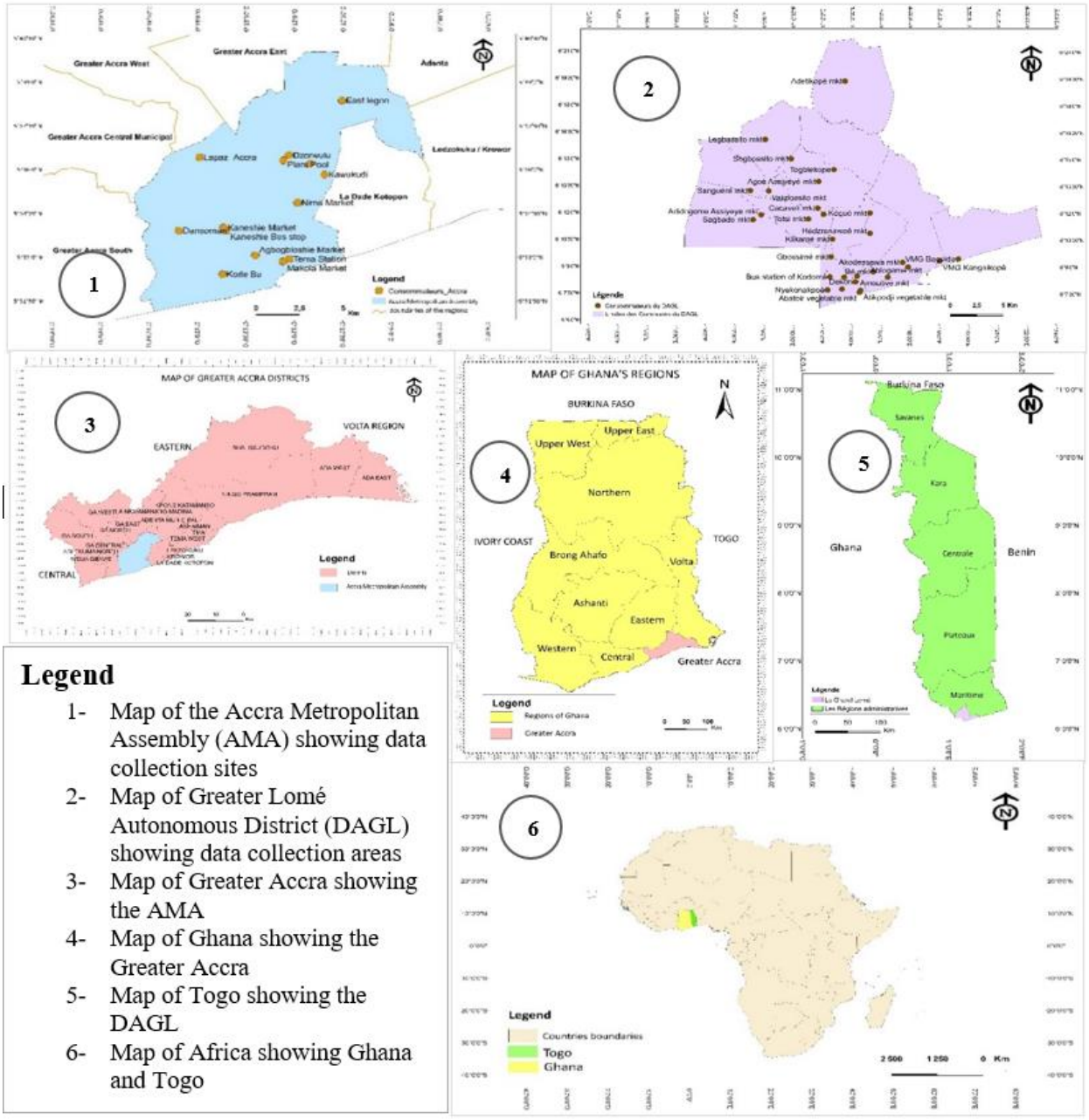

Figure 1.
Set of maps showing the target population sample areas.
Source: K. E. Assinou and K. Kpotchou, 2024.

2.2. Methods, Techniques and Tools

The quantitative multi-criteria approach was used to assess the health, nutritional and ecological sustainability of knowledge and good vegetable consumption practices in the Accra Metropolitan

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Assembly (AMA) and the Greater Lomé Autonomous District (DAGL). The main reason for the multidimensional method's choice is that the food process is associated with ins and outs of several orders (C.C. Esnouf and al., 2011, p. 179-180). In the context of this research, the dimensions of sustainability primarily taken into account are health (food and nutritional safety), environmental protection (losses, wastage and waste management), socio-economic well-being, access to food with technological tools and education in good food practices.

The Food Frequeny Questionnaire (FFQ) was used for the analysis. The FFQ is a technique for collecting data on individual diets in a locality, focusing on their implications for health (Data4Diets, 2023, p. 30-31). This technique is based on the principles of dietary diversity scores, in particular the Minimum Dietary Diversity for Women (Data4Diets, 2023, p. 16-18, 120-123; FAO, 2021b). In the context of this research, following the example of the forced association technique used in work on social representations, the FFQ makes it possible to propose a list of responses to a respondent and let him or her make one or more response choices in order to analyze the trends. Using this technique, lists of food groups, nutrients or certain food and nutritional information or practices were drawn up in order to understand the target population's food culture and grasp its sustainability implications in relation to the research objective. The questionnaire used was designed on the Kobotoolbox platform and administered via tablet using the KoboCollect application and Global Positioning System (GPS).

2.3. Sampling

Residents of the Accra Metropolitan Assembly and the Greater Lomé Autonomous District (DAGL) make up the parent population of the research. The target population comprises the men and women of the parent population aged 18 and over. These people were permanent residents of the AMA and DAGL for at least one (1) year prior to data collection. They were interviewed according to whether they were heads of households or whether they contributed in kind or in cash to the selection, acquisition, preservation, preparation and/or distribution of food among household members.

Voluntary and purposive sampling techniques were used to select the survey population (the sample). Respondents were selected based on reasoning linked to knowledge of their socio-cultural and demographic realities, and of the societal dynamics of the territory to which they belonged (E. Babbie, 2008, p. 203; J. Curwin and al., 2013; V.S. Kwol and al., 2020, p. 116). Respondents were interviewed in specific areas of the two cities characterized by large population clusters on working days. These areas of the two cities concerned by the research constitute business centers to which large numbers of people migrate from several localities (Y. Grafmeyer and J.-Y. Authier, 2015, p. 11-12, 14-16). This reflects the socio-cultural diversity that characterizes these urban centers in terms of knowledge, food practices and other vital and societal utilities. Data collection targeted respondents in bus stations, business centers near markets where vegetables are sold and catering services offered. Three hundred and ninety-four (394) people answered the questions during data collection. This number was divided equally between AMA and DAGL, i.e. one hundred and ninety-seven (197) respondents selected per agglomeration. This selection is based on the assumption that the population follows a normal distribution. The confidence level is therefore estimated at 95% and the precision level at 5%. In L. Kish (1965) assertion, the distribution of attributes lies between 20% and 80%, enabling a sample of thirty (30) to two hundred (200) statistical units to be selected. Furthermore, this sample is made up of sub-groups: one hundred and ninety-seven (197) respondents in Greater Lomé and Accra. The size of these sub-groups is defined according to the statistical logic of S. Sudman (1976) and D.I. Glenn (1992) who demonstrated that in a comparative situation, 20 to 50 observations per sub-group are sufficient to extend the results to the total population.

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2.4. Data Collection

In line with FAO's approach to the analysis of food and nutrition knowledge and practices, data collection was preceded by the training of assistant enumerators on the research objectives, sample composition, questionnaire organization as well as the use of the Kobokollect v2023.2.4 application (FAO, 2016). This served to equip them on the mastery of questionnaires, knowledge of all the sites, objects, actors and activities taken into account by the research. A pre-survey was then carried out to enable the interviewers to familiarize themselves with the tools. The principles of anonymity, confidentiality and the liberty to refuse or stop an interview in progress were respected. Interviews lasted between twenty (20) and thirty (30) minutes.

The following sites were visited in Accra: East Legon, Lapaz, Dansoman, Kaneshie bus stop, Tema train station, the area around Makola vegetable market, the area around Nima market and the area around Agbogbloshie vegetable market. In Greater Lomé, data were collected in the following localities: Dekon and surroundings, Kodomé bus station, Adidogomé assiyéyé, surroundings of Legbassito, Adétikopé, Sogbossito, Togblekopé, Agoè assiyéyé, Sanguéra, Vakpossito, Sagbado, Cacaveli, Totsi, Kégué, Hédzranawoé, Gbossimé, Klikamé, Akodessewa, Attikpodji and Amoutivé markets.

For the purposes of this research, vegetables are defined as "...the eatable parts of plants cultivated or harvested in the wild, in the raw state or in a minimally processed form" FAO (F. Beed and al., 2021, p. 2; FAO, 2021a, p. 5). The following categories of vegetables were considered for the research: fruiting vegetables (tomatoes, peppers, etc.), leafy vegetables (broad beans, cabbage, etc.), bulb vegetables (garlic, onions, etc.), root vegetables (carrots, beet, etc.), stem vegetables (celery, asparagus, etc.), flowering vegetables and budding vegetables (cauliflower, broccoli, etc.). Starchy vegetables, legumes and cereals have been excluded.

2.5. Data Processing, Display and Analysis

After importing the collected data from Kobotoolbox, Microsoft Office Excel 2019 was used to reconcile the sample composition. Google Earth Pro version 7.3.6.9345 was used to transform the collected GPS data into Keyhole Markup Language (KML) files. Arc GIS Desktop 10.8.2 was also used to generate point layers from the KML markers. The points obtained illustrate the data collection locations on the map in the "Physical presentation" section. Data were processed according to sustainability indicators divided into nutritional, health, environmental, socio-economic, and technological and food education dimensions.

Most questions are multiple choice. Thus, each correct knowledge or practice selected by a respondent is scored at one (1) point (M.N. Islam and al., 2023; N.A. Moreb and al., 2017). The score is zero (0) for incorrect knowledge and practices. The research indicators are verified by one or more questions and have been grouped into twelve categories that correspond to the sustainability aspects considered. For each variable modality linked to the questions verifying each indicator, the rates of correct answer scores were calculated in relation to the total number of respondents. The "passing score" or "acceptable sustainability score" corresponds to fifty (50) percent correct answers for each variable modality, variable and indicator. The score is "sufficiently good" if the rate of correct answers varies between fifty-one (51) and sixty-nine (69) percent. Scores are "high" if the proportion of valid responses is between seventy (70) and one hundred (100) percent. A score is "low" if it is less than fifty (50) percent.

The following formula is used to calculate the rates for the variable modalities of the questions corresponding to the indicators in general:

General formula 1:

$$Rate\ (T) = \frac{Scores\ for\ correct\ answers * 100}{Sample\ size * number\ of\ correct\ answers}$$

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For indicators grouped according to the sustainability dimensions considered, the following general formula for calculating score averages is adopted:

General formula 2:

$$\bar{x} = \sum \frac{x}{n} = \bar{x}c\ (\text{AMA\_DAGL})$$

Derived formulas :

- $\bar{x}_{C(AMA\_DAGL)} = \bar{x}_{C(AMA\_DAGL)}1 + \bar{x}_{C(AMA\_DAGL)}2 + \bar{x}_{C(AMA\_DAGL)}3 + \bar{x}_{C(AMA\_DAGL)}4 + \bar{x}_{C(AMA\_DAGL)}5 + \bar{x}_{C(AMA\_DAGL)}6 + \bar{x}_{C(AMA\_DAGL)}7 + \bar{x}_{C(AMA\_DAGL)}8 + \bar{x}_{C(AMA\_DAGL)}9 + \bar{x}_{C(AMA\_DAGL)}10 + \bar{x}_{C(AMA\_DAGL)}11 + \bar{x}_{C(AMA\_DAGL)}12 \ / \ 12$
- $\bar{x}_{C(AMA)} = \bar{x}_{C(AMA)}1 + \bar{x}_{C(AMA)}2 + \bar{x}_{C(AMA)}3 + \bar{x}_{C(AMA)}4 + \bar{x}_{C(AMA)}5 + \bar{x}_{C(AMA)}6 + \bar{x}_{C(AMA)}7 + \bar{x}_{C(AMA)}8 + \bar{x}_{C(AMA)}9 + \bar{x}_{C(AMA)}10 + \bar{x}_{C(AMA)}11 + \bar{x}_{C(AMA)}12 \ / \ 12$
- $\bar{x}_{C(DAGL)} = \bar{x}_{C(DAGL)}1 + \bar{x}_{C(DAGL)}2 + \bar{x}_{C(DAGL)}3 + \bar{x}_{C(DAGL)}4 + \bar{x}_{C(DAGL)}5 + \bar{x}_{C(DAGL)}6 + \bar{x}_{C(DAGL)}7 + \bar{x}_{C(DAGL)}8 + \bar{x}_{C(DAGL)}9 + \bar{x}_{C(DAGL)}10 + \bar{x}_{C(DAGL)}11 + \bar{x}_{C(DAGL)}12 \ / \ 12$
- $\bar{x}_{C(AMA\_DAGL)}1 = \bar{x}_{C(AMA)}1 + \bar{x}_{C(DAGL)}1 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}2 = \bar{x}_{C(AMA)}2 + \bar{x}_{C(DAGL)}2 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}3 = \bar{x}_{C(AMA)}3 + \bar{x}_{C(DAGL)}3 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}4 = \bar{x}_{C(AMA)}4 + \bar{x}_{C(DAGL)}4 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}5 = \bar{x}_{C(AMA)}5 + \bar{x}_{C(DAGL)}5 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}6 = \bar{x}_{C(AMA)}6 + \bar{x}_{C(DAGL)}6 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}7 = \bar{x}_{C(AMA)}7 + \bar{x}_{C(DAGL)}7 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}8 = \bar{x}_{C(AMA)}8 + \bar{x}_{C(DAGL)}8 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}9 = \bar{x}_{C(AMA)}9 + \bar{x}_{C(DAGL)}9 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}10 = \bar{x}_{C(AMA)}10 + \bar{x}_{C(DAGL)}10 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}11 = \bar{x}_{C(AMA)}11 + \bar{x}_{C(DAGL)}11 \ / \ 2$
- $\bar{x}_{C(AMA\_DAGL)}12 = \bar{x}_{C(AMA)}12 + \bar{x}_{C(DAGL)}12 \ / \ 2$

$\bar{x}$ ou $\bar{x}_{C(AMA\_DAGL)}$ corresponds to the overall average of the proportions of sustainable knowledge and practices of AMA and DAGL eaters from health (physical, mental and social well-being), environmental, nutritional, socioeconomic related to food education and socioeconomic points of view.

$\sum x$ represents the sum of the different values averaged.

n is the number of values averaged.

$\bar{x}_{C(AMA)}$ et $\bar{x}_{C(DAGL)}$ are the means of the proportions of socioeconomic, environmental, health, nutritional knowledge, and practices (CP) respectively considered for consumers in Accra and Greater Lomé.

$\bar{x}_{C(AMA)}1$; $\bar{x}_{C(AMA)}2$; $\bar{x}_{C(AMA)}3$; $\bar{x}_{C(AMA)}4$; $\bar{x}_{C(AMA)}5$; $\bar{x}_{C(AMA)}6$; $\bar{x}_{C(AMA)}7$; $\bar{x}_{C(AMA)}8$; $\bar{x}_{C(AMA)}9$; $\bar{x}_{C(AMA)}10$; $\bar{x}_{C(AMA)}11$; $\bar{x}_{C(AMA)}12$; $\bar{x}_{C(DAGL)}1$; $\bar{x}_{C(DAGL)}2$; $\bar{x}_{C(DAGL)}3$; $\bar{x}_{C(DAGL)}4$; $\bar{x}_{C(DAGL)}5$; $\bar{x}_{C(DAGL)}6$; $\bar{x}_{C(DAGL)}7$; $\bar{x}_{C(DAGL)}8$; $\bar{x}_{C(DAGL)}9$; $\bar{x}_{C(DAGL)}10$ + $\bar{x}_{C(DAGL)}11$+ $\bar{x}_{C(DAGL)}12$ are obtained by the average percentages of sustainability rates calculated for the 12 groups of sustainability indicators taken into account for the research according to Accra or Lomé eaters. They are calculated using the second formula.

C(AMA) and C(DAGL) represent Accra and Greater Lomé eaters respectively.

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$\bar{x}_{C(AMA\_DAGL)}1 + \bar{x}_{C(AMA\_DAGL)}2 + \bar{x}_{C(AMA\_DAGL)}3 + \bar{x}_{C(AMA\_DAGL)}4 + \bar{x}_{C(AMA\_DAGL)}5 + \bar{x}_{C(AMA\_DAGL)}6 + \bar{x}_{C(AMA\_DAGL)}7 + \bar{x}_{C(AMA\_DAGL)}8 + \bar{x}_{C(AMA\_DAGL)}9 + \bar{x}_{C(AMA\_DAGL)}10 + \bar{x}_{C(AMA\_DAGL)}11 + \bar{x}_{C(AMA\_DAGL)}$ are the overall averages of sustainability rates calculated from the knowledge and practices of surveyed eaters in Accra and Lomé according to the twelve (12) selected indicators :

- $\bar{x}c_{AMA}1$ and $\bar{x}c_{DGAL}1$: average knowledge levels of Accra and Lomé consumers on the number of times required to eat vegetables on a daily basis ;
- $\bar{x}c_{AMA}2$ and $\bar{x}c_{DAGL}2$: mean levels of daily vegetable consumption by Accra and Lomé respondents ;
- $\bar{x}c_{AMA}3$ and $\bar{x}c_{DAGL}3$: Average knowledge rates of Accra and Lomé respondents on of respondents' knowledge on the necessity of consuming vegetables at different meals of the day ;
- $\bar{x}c_{AMA}4$ and $\bar{x}c_{DGAL}4$: average vegetable consumption rates by respondents at the main meals of the day in Accra and Lomé ;
- $\bar{x}c_{AMA}5$ and $\bar{x}c_{DAGL}5$: respondents' level of knowledge of vegetable nutrient intake (carbohydrates, lipids, proteins, vitamins, mineral salts) ;
- $\bar{x}c_{AMA}6$ and $\bar{x}c_{DAGL}6$: consumers' level of knowledge regarding the contribution of each type of macronutrient from vegetables to their bodies (carbohydrates, lipids, protides, vitamins, mineral salts, water) ;
- $\bar{x}c_{AMA}7$ and $\bar{x}c_{DGAL}7$: average proportions of consumers' knowledge in both cities of the necessity of vegetables for a balanced diet ;
- $\bar{x}c_{AMA}8$ and $\bar{x}c_{DAGL}8$: average proportions of consideration of age, gender, physical activity, health status and morphotype of AMA and DAGL eaters ;
- $\bar{x}c_{AMA}9$ and $\bar{x}c_{DAGL}9$: eaters' level of knowledge about the disadvantages of poor vegetable preservation on their nutritional quality (ix-1) or on consumer health (ix-2): ix
- $\bar{x}c_{AMA}10$ and $\bar{x}c_{DAGL}10$: rate of good preservation practices (x-1), management of putrefied vegetables (x-2) and waste from vegetable handling (x-3): x ;
- $\bar{x}c_{AMA}11$ and $\bar{x}c_{DAGL}11$: level of use of social networks (xi-1) and apps (xi-2) by interviewees in food or dish ordering processes (xi);
- $\bar{x}c_{AMA}12$ and $\bar{x}c_{DAGL}12$: participation rate of respondents in public projects (xii-1) or associations and NGOs (xii-2) related to food education and nutrition.

The following international documents and standards served as a reference for the selection of these indicators in relation to the research objective and analysis

- "Healthy and sustainable diets, guiding principles" (FAO/OMS, 2020);
- " Diet, nutrition and chronic disease prevention"(OMS/FAO, 2003);
- "Ghana: National Food-Based Dietary Guidelines-2023" (MFA/GSPH, 2023) ;
- "Codex Alimentarius: Codes of Hygienic Practice for Fresh Fruits and Vegetables : CXC 53-2003" (FAO/WHO, 2017) ;
- "Codex Alimentarius: General Principles of Food Hygiene: CXC 1-1969" (FAO/WHO, 2023) ;
- Global Reporting Initiative 2023(GSSB, 2023) theme 13;
- Sustainable Development Goals (SDGs).

Results are presented in graphical form, considering all indicators.

The reference theory underlying the analysis is nutrition ecology. This is an interdisciplinary approach to human nutrition that studies food systems or the consumption behaviors of eaters. The theory focuses on the nutritional, health, socioeconomic and environmental effects of eaters' food behaviors (K. Schneider and I. Hoffmann, 2011, p. 1-2). All the components of food value chains then constitute a focus of nutritional ecology oriented towards the aforementioned sustainability aspects. The

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analysis of this theory takes into account all levels of food circuits: production, storage, transport, processing, packaging, marketing, distribution, preparation, consumption and waste management (C. Leitzmann, 2003). Although the various aspects of food sustainability are considered, the analysis is limited to the final consumers.

3. Results

3.1. Socio-Demographic Profiles of Sampled People

Age, level of education, social class, self-perceived state of health and morphotype are variables that were essential in the analysis of the research results, in general. In Figure 2, looking at the distribution of respondents according to age, it is noted that 71.1% are between 18 and 35 while 26% are over 36. The same trend can be observed at both DAGL and AMA. In terms of level of education, 60.4% of respondents had attended secondary school; in the DAGL sample, 48.8% were questioned, while this category of literate people accounted for 72% of AMA observations. In the DAGL and AMA, of the 194 educated people who had finished elementary school, there were 15 Loméans (7.6%) and 18 Accra residents (9.1%). The illiterates interviewed make up 8.1% of the DAGL sample, versus 4.6% for AMA, i.e. 6.3% of the overall sample. In terms of health, 94.6% of respondents affirmed that they are in a good state of physical and mental health; 91.3% of respondents in Greater Lomé made the same assertion, versus 98% in Accra. With regard to the distribution of the targeted people according to their morphotypes, it was observed that 40.1% of them are slender. This morphotype category represents 39.1% of the DAGL sample and 41.1% of the AMA sample. People who said they were slim made up 27.9% of the total number surveyed; they made up 24.9% of respondents in Greater Lomé, compared with 31% in the Ghanaian capital. The table below shows this breakdown in detail.

Table 1
Sociodemographic repartition of respondents.

Categories		AMA		DAGL		All surveys	
		Effective	Rate (%)	Effective	Rate (%)	Effective	Rate (%)
Distribution of consumers by gender	Feminine	75	38.1	95	48.2	170	43.1
	Male	122	61.9	102	51.8	224	56.9
	Total	197	100.0	197	100.0	394	100
Distribution of surveys by age	18-25	46	23.4	82	41.6	128	32.5
	26-35	90	45.7	62	31.5	152	38.6
	36-45	38	19.3	33	16.8	71	18.0
	46-55	19	9.6	15	7.6	34	8.6
	56 years and over	4	2.0	5	2.5	9	2.3
	Total	197	100.0	197	100.0	394	100
Distribution of surveys according to level of education	Uneducated	9	4.6	16	8.1	25	6.3
	Primary	15	7.6	18	9.1	33	8.4
	Secondary 1 (College)	57	28.9	36	18.3	93	23.6
	Secondary 2 (High school)	85	43.1	60	30.5	145	36.8
	Higher 1 (BTS,	25	12.7	66	33.5	91	23.1

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Categories		AMA		DAGL		All surveys	
		Effective	Rate (%)	Effective	Rate (%)	Effective	Rate (%)
	License, Master's)						
	Higher 2 (DESS/DEA /Master/Doctorate)	6	3.0	1	0.5	7	1.8
	Total	197	100.0	197	100.0	394	100
Distribution according to perceived social class of belonging	Modest class	96	48.7	119	60.4	215	54.6
	Middle class	91	46.2	72	36.5	163	41.4
	Higher class	ten	5.1	6	3.0	16	4.1
	Total	197	100.0	197	100.0	394	100
Distribution according to health status	I'm not healthy at all	1	0.5	6	3.0	7	1.8
	I'm not really healthy	3	1.5	11	5.6	14	3.6
	I am healthy	28	14.2	151	76.6	179	45.4
	I am in very good health	91	46.2	28	14.2	119	30.2
	I am in perfect health	74	37.6	1	0.5	75	19.0
	Total	197	100.0	197	100.0	394	100
Distribution according to morphotype	Overweight	14	7.1	1	0.5	15	3.8
	Endomorph (Round or overweight)	41	20.8	70	35.5	111	28.2
	Mesomorph (Slender)	81	41.1	77	39.1	158	40.1
	Hectomorph (Chopped)	61	31.0	49	24.9	110	27.9
	Total	197	100.0	197	100.0	394	100

Source: K. E. Assinou and K. Kpotchou, 2024.

The socio-demographic and physiological profile of the respondents shows that they are predominantly young people (71.1% aged between 18 and 35), a trend that reflects the age structure of the populations of sub-Saharan Africa. Respondents are also 93.7% literate, and 85.3% of them have completed Secondary School. In addition, 94.6% of respondents are convinced that they are in good health. This perception may depend on their young age and the fact that 68% of them are not overweight.

Although the inhabitants of the capital cities of Ghana and Togo surveyed are young (71.1% aged between 18 and 35) and educated (93.7% educated) for the most part, the results overall show that they

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have low levels of knowledge and good practice when it comes to adopting a sustainable diet, starting with their daily vegetable consumption patterns.

3.2. Gaps Between Food and Nutrition Knowledge and Public Health Risks in Accra and Greater Lomé

This part of the results essentially reveals that the knowledge rates of the inhabitants of the cities targeted by the research are generally low in relation to the required daily number of vegetables consumed, their inclusion in the various meals of the day, their nutritional composition and their importance in relation to a balanced diet. Worse still, these rates of knowledge are higher than those related to recommended dietary practices in most cases. Nutritional deficiencies and related illnesses are the evidence of this.

4.2.1. Loméans and Accra residents' lack of knowledge about the daily consumption of vegetables and their incorporation into main meals

Les enquêtés, dans une considération générale, ont un niveau de connaissance faible quant au nombre de fois nécessaire à la consommation de légumes par jour. Respondents' knowledge of the necessary number of times to eat vegetables per day is generally low. In Figure n°2 below presented, on average 17,51% ($\bar{xc}_{AMA\_DAGL}1$) of them know that vegetables should be consumed at least three times a day. But in the DAGL, this level of knowledge is higher than in the AMA : 63,45% ($\bar{xc}_{DAGL}1$) contre 17,64% ($\bar{xc}_{AMA}1$).

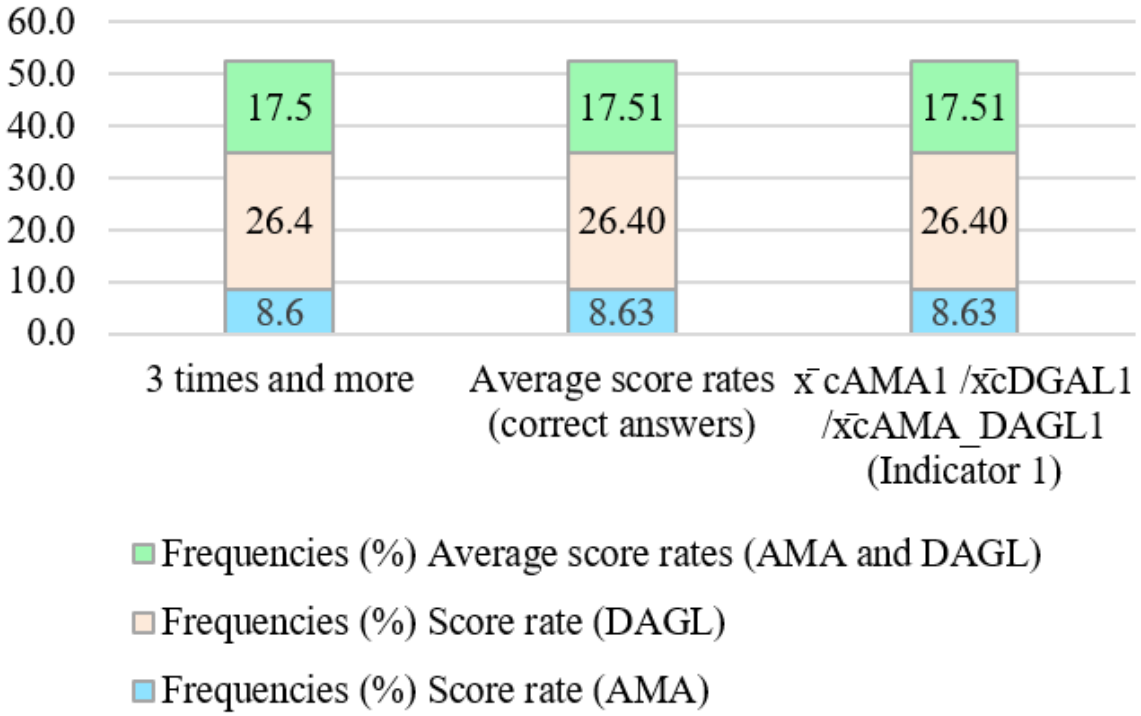

Figure 2.
Levels of knowledge of respondents on the number of vegetables consumed daily.
Source: K. E. Assinou and K. Kpotchou, 2024.

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Similarly, the rate of consumption of vegetables at least three times a day is very low, although slightly higher than the knowledge rate (Figure no. 4); it averages 24.62% ($\bar{x}_{cAMA\_DAGL2}$). However, while vegetable consumption three times a day is higher in practice (37.6%) than in knowledge in Accra (8.6%), the opposite trend is observed among Loméans: their propensity to consume vegetables three times a day is lower than their level of knowledge.

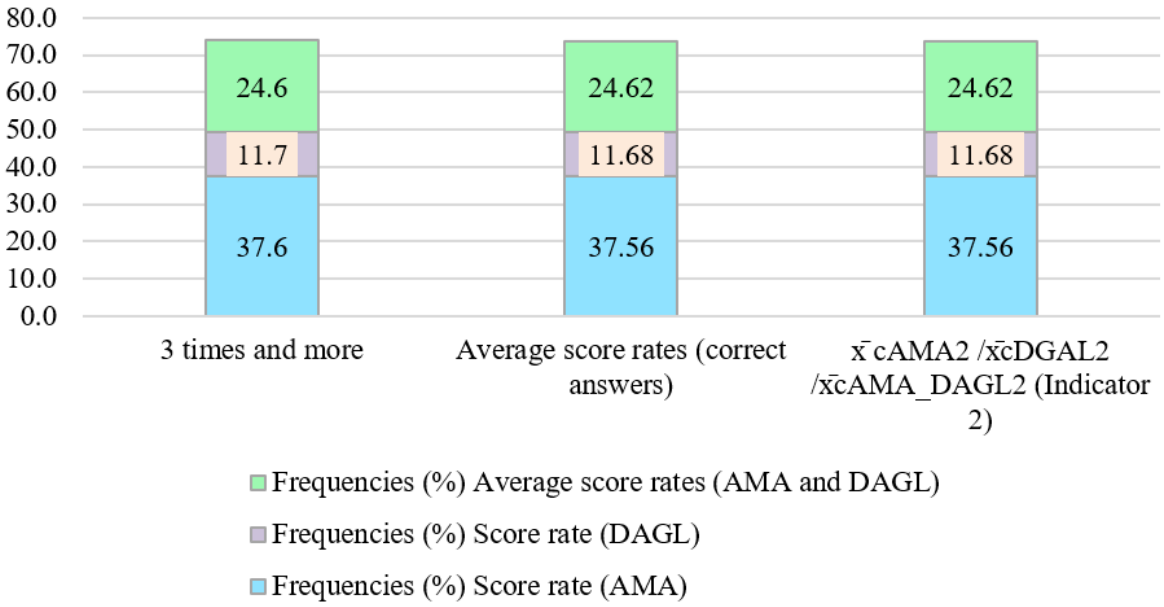

Figure 3.
Levels of vegetable consumption of respondents on a daily basis.
Source: K. E. Assinou and K. Kpotchou, 2024.

Based on the lower level of knowledge of Accra's inhabitants in relation to their rate of daily vegetable consumption practices, it is irrefutable that the propensity to consume these foods three times a day is not necessarily explained by the fact of having knowledge of them. On the one hand, standard of living may explain it, since the socio-demographic profile of respondents shows that in the Ghanaian capital, those who consider themselves to belong to the modest social class are less numerous (48.7%) than those in the Togolese capital who are aware of being in this category (60.4%). However, the rate of good practice is higher in Accra than in Lomé. On the other hand, while 85.3% of those interviewed have attended secondary school and 71.1% are between 18 and 35 years of age, this does not determine their propensity to know about the importance of consuming vegetables at least three times a day, or to apply themselves to doing so. This suggests that daily vegetable consumption is potentially influenced by socio-economic and health constraints, and above all by eating habits that are not necessarily conducive to a quality diet.

These trends are confirmed by the third and fourth graphs. Compared to the data in the first and second graphs, the latter illustrate a high degree of confusion among respondents regarding their levels of knowledge and consumption rates of vegetables at the main meals of the day (breakfast, lunch and dinner). The first graph shows that only 17.51% of respondents know that they should eat vegetables at least three times a day, but only 24.6% actually do so. In contrast, an average of 53.62% ($\bar{x}_{cAMA\_DAGL3}$) of Loméans and Accra residents know that it's important to include vegetables at the main meals of the day (Figure 4), but only 33.50% ($\bar{x}_{cAMA\_DAGL4}$) actually do so in practice (Figure no. 5).

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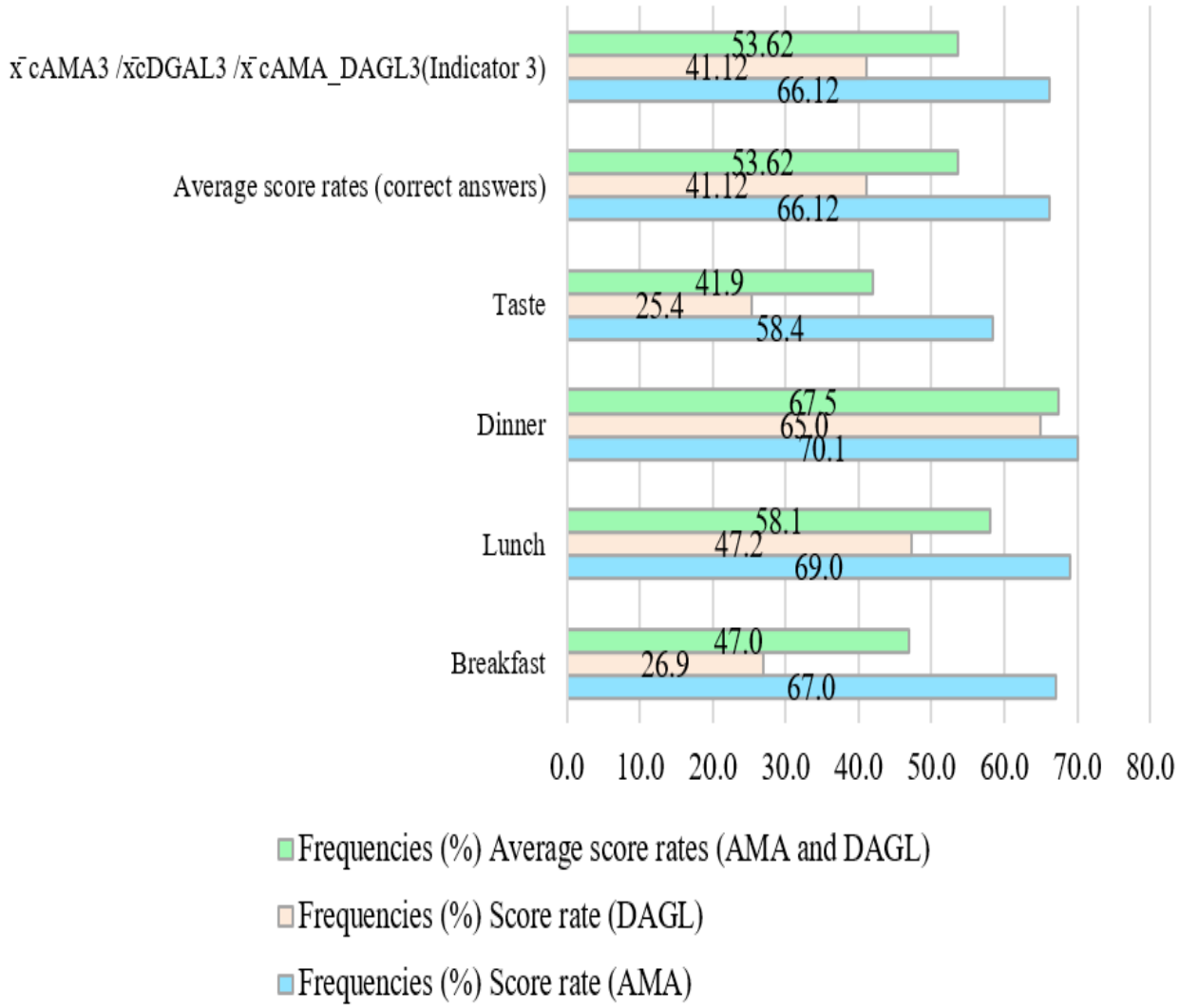

Figure 4.
Level of knowledge of respondents on the necessity of consuming vegetables at different meals of the day.
Source: K. E. Assinou and K. Kpotchou, 2024.

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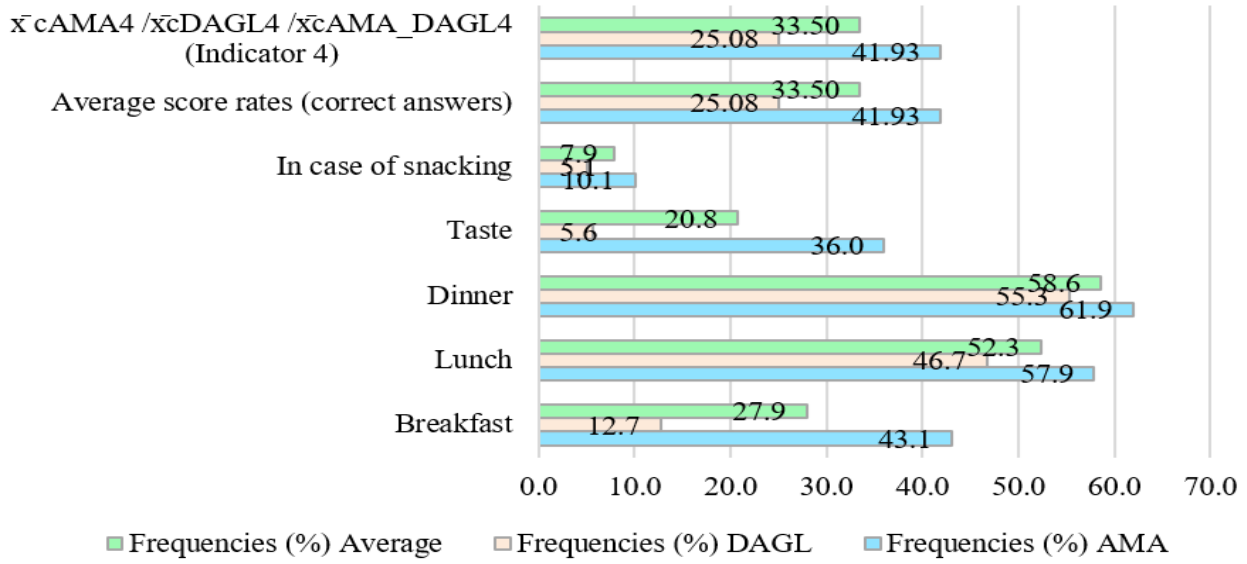

Figure 5.
Levels of vegetable consumption by respondents at different meals of the day.
Source: K. E. Assinou and K. Kpotchou, 2024.

These low rates of consumption can be explained less by the respondents' physical, health and economic ability to eat vegetable meals at breakfast than by their socialization around food days. Indeed, both in Accra and Greater Lomé, respondents are more likely to eat vegetables at lunch (57.9% for AMA and 46.7% for DAGL) and dinner (61.9% for AMA and 55.3% for DAGL) than at breakfast (43.1% for AMA and 12.7% for DAGL). This shows that for the most part, in the mornings, they make do with dishes that do not necessarily require vegetable accompaniments. This is much more a reflection of the culture in these towns of including vegetables more in the last two meals of the day than in the morning dishes. As a result of this food culture, the respondents do not know whether the number of times they should eat vegetables per day differs from the inclusion of this food group in the three main meals of the day. Hence, the doubts and uncertainties reflected in the figures in Figure 2 and 3.

This situation may also be due to the inability of AMA and DAGL residents to know for sure about the potential nutrient compounds in the vegetables they eat, the roles they may play in their bodies, and the quantities they are generally recommended to consume (Figures 6 and 7).

3.2.2. Uncertainties of AMA and DAGL Residents on the Nutrient Intake of Vegetables by Type of Nutrient

Figure 6 shows an insignificant average rate of knowledge among AMA and DAGL residents regarding the macronutrient or micronutrient intake of vegetables ($\bar{xc}_{AMA\_DAGL}5=30,86\%$). Between the two cities, the difference in this rate is only 6.5%, implying that the average rate of unawareness of vegetable nutrient intake is as much observed in Accra ($\bar{xc}_{AMA}5=34,11\%$) as in Greater Lomé ($\bar{xc}_{DAGL}5=27,61\%$). Except for vitamins which respondents on both sides recognize as composing vegetables at an average rate of 64.5% (68% in AMA and 60.9% in DAGL), in the two cities, they are poorly informed about the nutritional composition of vegetables. The average number of carbohydrates chosen was 23.6%, lipids 9.4%, proteins 19% and minerals 37.8%.

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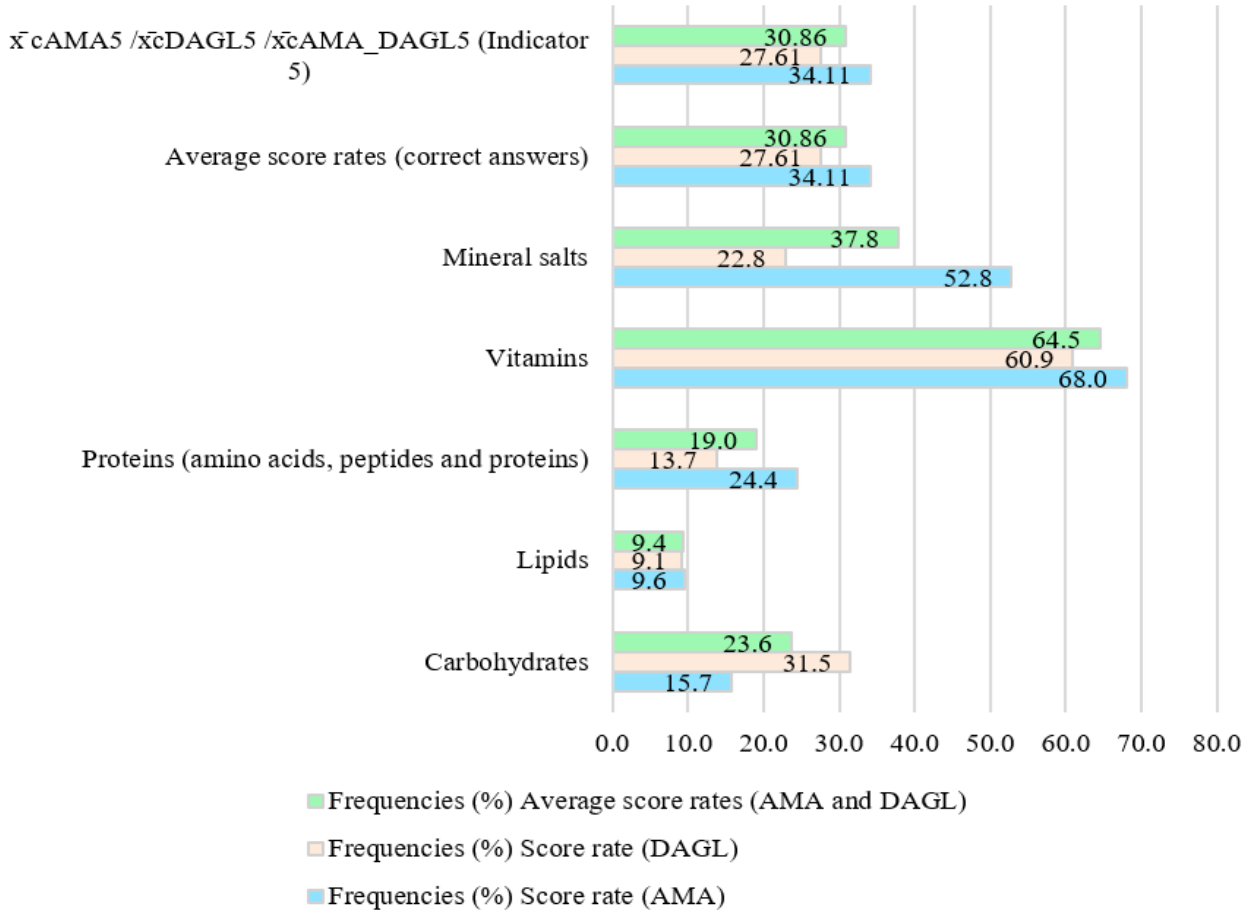

Figure 6.
Levels of knowledge of respondents regarding the nutrient intake of vegetables (Carbohydrates, lipids, proteins, vitamins, mineral salts, water).
Source: K. E. Assinou and K. Kpotchou, 2024.

Without a doubt, around 69% of Loméans and Accra residents are unaware of the nutritional importance of vegetables. To verify this result, the interviewees were also tested on their knowledge levels in relation to the contribution of each type of vegetable nutrient to their bodies. Admittedly, the average rate observed is 41.02% ($\bar{x}c_{AMA\_DAGL}6$), but it's almost 60% in Accra ($\bar{x}c_{AMA}6$) in contrast to Greater Lomé where it's very low (22,34%= $\bar{x}c_{DAGL}6$). Clearly, in relation to all the macronutrients under observation, the knowledge rates of the Accra respondents are higher than those of the Lomé respondents, and all exceed 58% with the exception of fiber carbohydrates: carbohydrates sugars (82.7% in AMA vs. 50.3% in DAGL); lipids (58.9% in AMA vs. 19.3% in DAGL); proteins (82.2% in AMA vs. 14.2% in DAGL); water (71.6% in AMA vs. 23.9% in DAGL).

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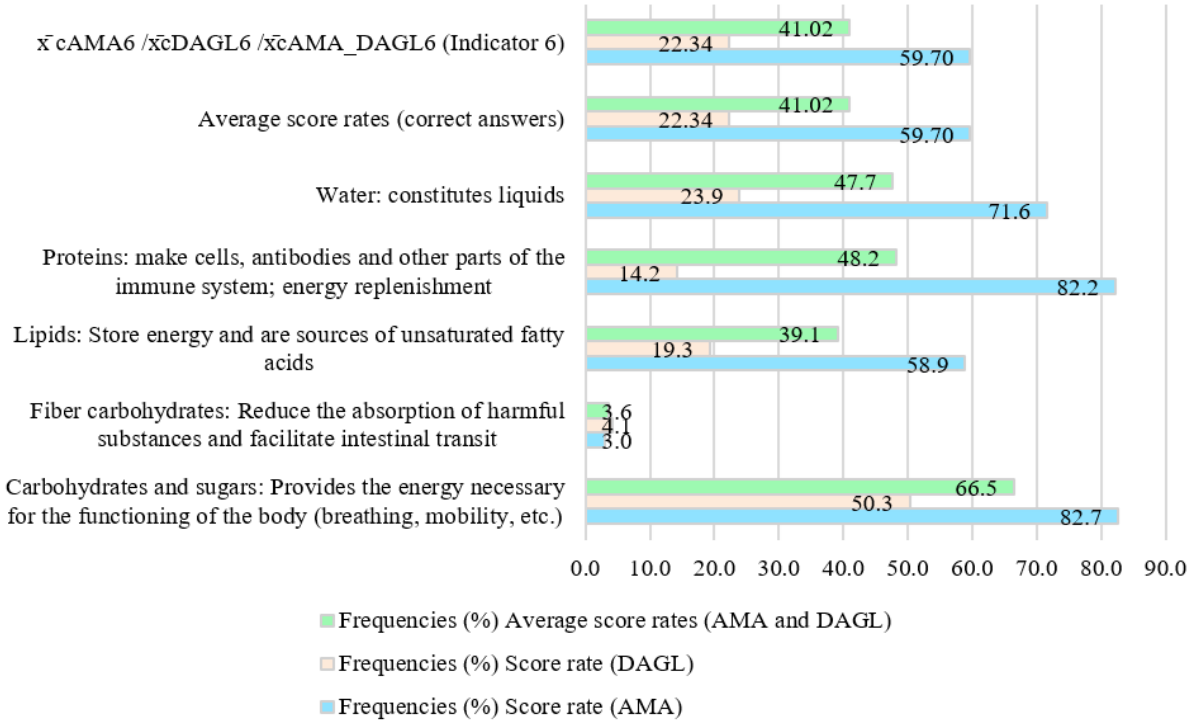

Figure 7.
Consumer knowledge rate regarding the contributions of each type of macronutrients from vegetables to their bodies.
Source: K. E. Assinou and K. Kpotchou, 2024.

These results further confirm the assertion that respondents' knowledge of food and nutrition does not determine their eating habits. This is confirmed by the data in Figure 8. Reading this figure, we can see clearly that, on average, the inhabitants (77, 7%= $\bar{x}c_{AMA\_DAGL}7$) of both towns know that vegetables are necessary for a balanced diet, as they were taught at school. But here again, the level of nutritional knowledge is higher in Accra (86, 8%= $\bar{x}c_{AMA}7$) than in Greater Lomé (68, 5%= $\bar{x}c_{DAGL}7$).

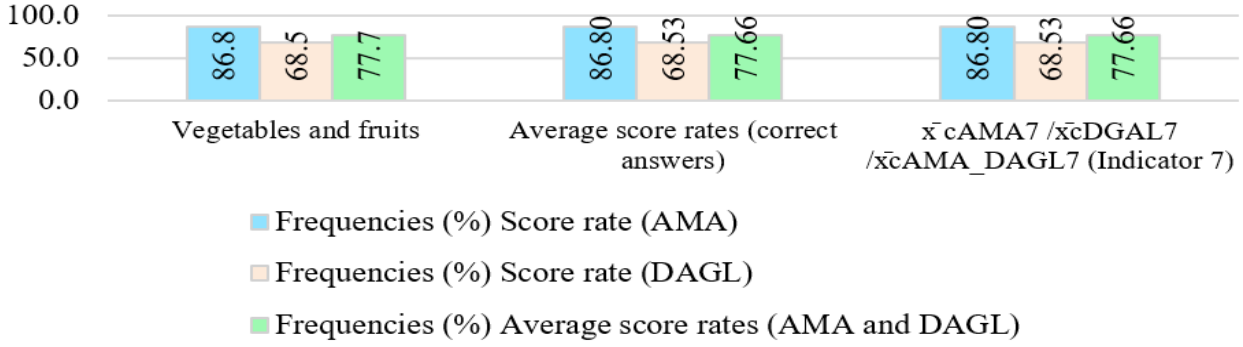

Figure 8.
Consumer knowledge of the need for vegetables for a balanced diet.
Source: K. E. Assinou and K. Kpotchou, 2024.

If 53.62% of people surveyed know that it's important to include vegetables in the main meals of the day and 66.5% of the same sample don't put the recommendation into practice, then around 65% of the

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population of Accra and Greater Lomé are exposed in the long term to major risks of health pathologies linked to dietary deficiencies, hidden hunger and nutritional excesses. The nutritional costs of these results are clearly energy, protein and mineral deficiencies, as well as avitaminosis, which can lead to illnesses such as marasmus, kwashiorkor, anemia, goiter, wasting, stunted growth, low weight, rickets, scurvy, beriberi, skin lesions, intense fatigue, insomnia, nervous, digestive and neurological disorders, and so on. These results cannot be detached from the possibility that Loméans and Accra residents take little account of certain socio- demographic variables in the preparation and distribution of meals between family members, referring to gender, age, professional activity, state of health and nutrient composition. This is shown in Figure 9.

3.3. Nutrient and Health Insecurities at AMA and DAGL on Taking Account of the Biophysical and Sociodemographic Characteristics of Eaters in Meal Distribution: Focus on Vegetables

Gender, daily activity, enjoyment and nutrient composition are "neglected" variables in food preparation and distribution at both AMA and DAGL, in contrast to Age, perceived state of health and quantity of food to be consumed. Overall, the eighth Figure illustrates the following: the average rate of consideration of all of these above-mentioned elements turns out to be negative for both cities (44,82%=$\bar{x}c_{AMA\_DAGL}8$). But it is 51.78% in Accra ($\bar{x}c_{AMA}8$) while it is limited to 37.85% ($\bar{x}c_{DAGL}8$) in Greater Lomé. This trend is more associated with age and daily activity, but is not the same concerning the rest of the aforementioned variables.

In Accra, more than in the Togolese capital, age and daily activity are more than 50% taken into account: age (52.3% > 42.6%) and daily activity (58.4>39.6). While these disparities do emerge, some variables are considered above or below 50% in food preparation, preservation and consumption in both conurbations. With regard to the variables taken into account by eaters in both capitals at over 50%, we distinguish between the state of health (78.7% in AMA and 60.9% in DAGL) and the quantity of food to be ingested (71.6% in AMA and 66% in DAGL). The variable modalities taken into account by less than 50% eaters are gender (23.9% in Accra and 22.8% in Lomé), pleasure (34.5% in Accra and 17.8% in Lomé) and nutrient composition (43.1% in Accra and 15.2% in Lomé).

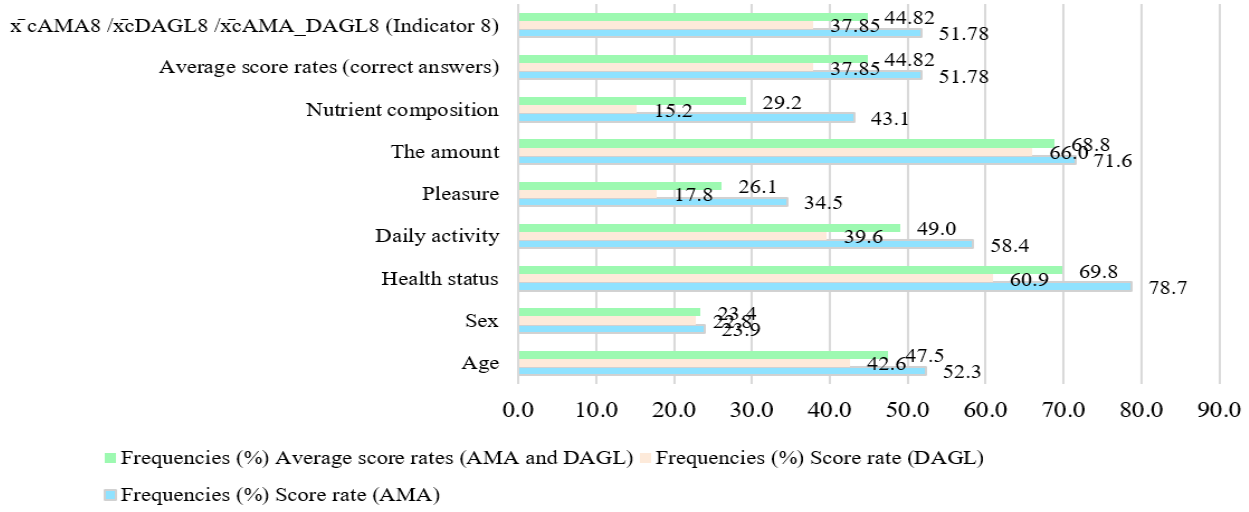

Figure 9.
Taking into account essential variables by respondents in the preparation, conservation and consumption of vegetables and other foods.
Source: K. E. Assinou and K. Kpotchou, 2024.

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These data show that in the capital cities of Ghana (79%) and Togo (60%), it is satiety that matters most to city dwellers when it comes to eating, unless people are showing symptoms of ill health. What's more worrying is that in both urban areas, less than 50% of residents are interested in the nutritional content of dishes, meals and gender. Women's diets, especially those of childbearing age, need to be rich in nutrients such as folic acid, iron, calcium and vitamin D. If they fail to do so, they are exposing themselves to health risks. Failure to do so exposes them to blood deficiencies, extreme fatigue, bone loss, malformations in their children and other chronic illnesses related to nutritional deficiencies. In addition, around 60% of Loméans are exposed to nutritional excesses, deficiencies and imbalances of all kinds, as long as they do not take into account the distribution of meals according to physical activity and age. This finding also helps to explain the double nutritional burden suffered by the populations of sub-Saharan African countries. These results show that the role of vegetables in the diets of over 50% of Loméans and Accra residents is neglected, since they are the most important sources of micronutrients (vitamins, minerals) and even macronutrients (proteins and fibers) essential to human nutrition.

If the target population is put on a diet that proves to be poor in view of the above results, this may also depend on people's levels of knowledge about the disadvantages of badly preserved vegetables on their qualities or on consumers' health.

3.4. Lack of Awareness among AMA And DAGL Residents of the Health and Nutritional Hazards of Improperly Preserved Vegetables

Residents of AMA and DAGL have low levels of knowledge about the disadvantages of bad storage conditions for vegetables and other foods, both in terms of quality and consumer health: 41.16% (Figure 10) and 33.07% (Figure 11) respectively. However, consumers in Greater Lomé know more than those in Accra about the health hazards of unclean food storage: 9.34% < 40.61%. The opposite trend can be observed in respondents' knowledge of the harmful effects of poorly preserved vegetables on their quality. These knowledge levels are averaged at 33.07% ($\bar{xc}_{AMA\_DAGL}9$) in both agglomerations. But they tend to be less insignificant in Greater Lomé (36,97%=$\bar{xc}_{DAGL}9$) than in Accra (29,16%=$\bar{xc}_{AMA}9$).

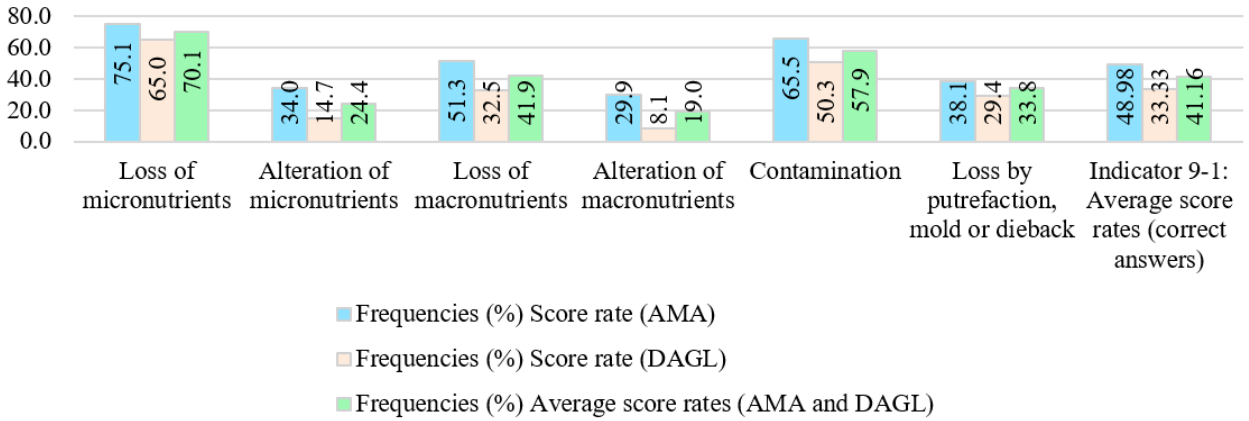

Figure 10.
Levels of consumer knowledge about the potential drawbacks of poor vegetable preservation on its quality and nutritional constitution.
Source: K. E. Assinou and K. Kpotchou, 2024.

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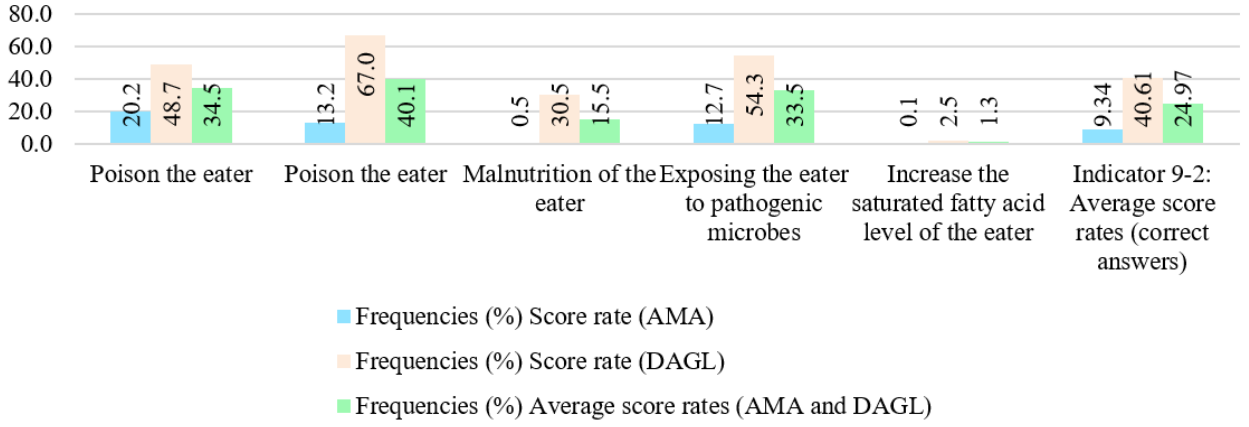

Figure 1.
Consumers' awareness of the health risks associated with careless or inadequate food preservation.
Source: K. E. Assinou and K. Kpotchou, 2024.

In both Accra and Greater Lomé, only 24.4% and 19% of people questioned are respectively aware that poor vegetable preservation can lead to micronutrient and macronutrient deterioration (Figure no. 10). Even in the case of losses, only 33.8% were unaware of this at the time the question was asked. However, it should be noted that in both cities, between 65% (DAGL) and 75% (AMA) of those interviewed were informed that preserving vegetables incorrectly could lead to micronutrient losses. Similarly, between 50% (Greater Lomé) and 65% (Accra) were aware of the risks of contamination associated with inefficient vegetable preservation.

When it comes to the health of eaters (Figure n°11), many are not overly concerned. With the exception of 67% of DAGL respondents who know that badly conserved vegetables can make consumers ill, only 13.2% of Accra respondents think so. These results show that over 50% of eaters in Accra and Greater Lomé are exposed to risks of undernutrition (avitaminoses, energy, protein and mineral deficiencies). Likewise, above 60%, people living in these two cities can hardly avoid intoxications (viruses, pathogenic bacteria), food allergies and chemical risks linked to the contamination of the vegetables they eat.

These data indicate the possibility of major vegetable losses in the AMA and DAGL, with all their environmental implications.

3.5. Vegetable Loss Risks and Environmental, Nutritional and Economic Implications in the Capital Cities of Togo and Ghana

In both Accra and Greater Lomé, the cumulative rates of good preservation practices for vegetables in good condition are positive (Figure 12) in both cities (86.80% in Accra and 79.70% in Greater Lomé). Obtained from single choice questions, they are on average 83.25%. However, the most widely used vegetable preservation technique is chilling (average 55.8%), as opposed to steaming (13.2%), drying (7.4%) and salting (6.9%). However, good practices for treating rotting vegetables (Figure n°13) are adopted at an average rate of almost null (2.54%). In fact, the average rate of discarding putrefying vegetables (bad practice) is very high (78.7%), compared with that of processing them (good practice) for other uses (2.5%). Waste management practices for vegetable preservation, preparation and post-consumption in Lomé and Accra are equally bad (Figure n°14). Here, the average rate is 16.50% with a very high proportion of waste management practices that are wrong (84.3%), as opposed to good practices, which are almost non-existent.

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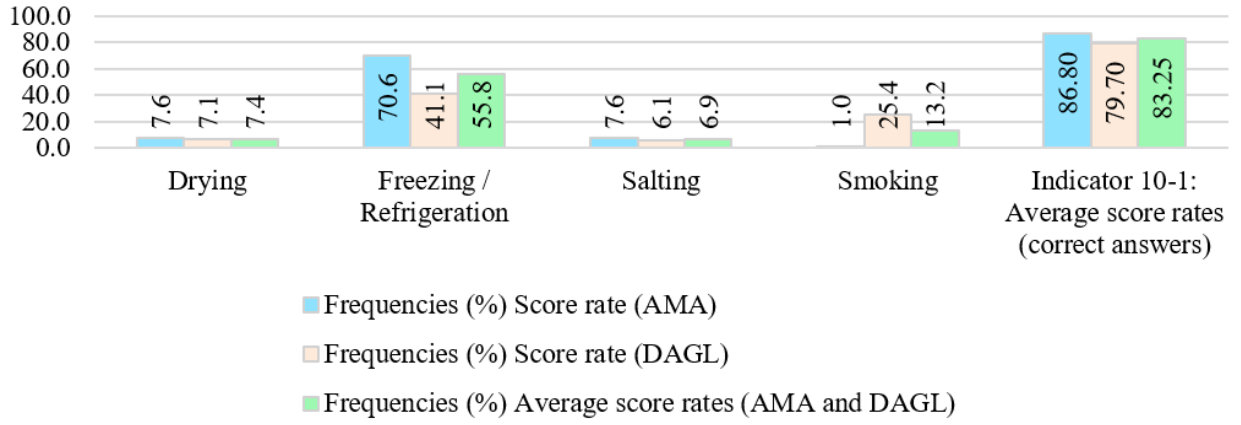

Figure 2.
Rate of good preservation practices for vegetables in 'fair' condition.
Source: K. E. Assinou and K. Kpotchou, 2024.

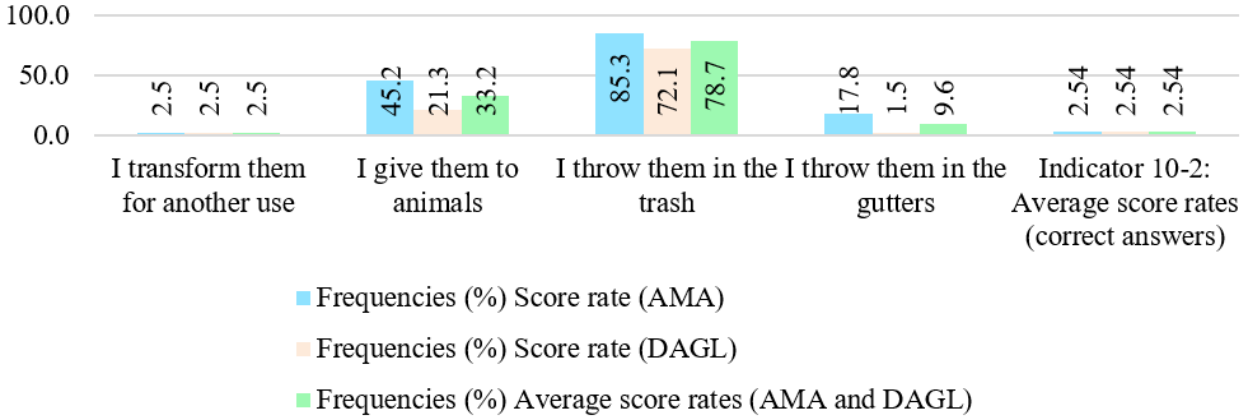

Figure 3.
Rate of good practice in the treatment of mouldy or decaying vegetables.
Source: K. E. Assinou and K. Kpotchou, 2024.

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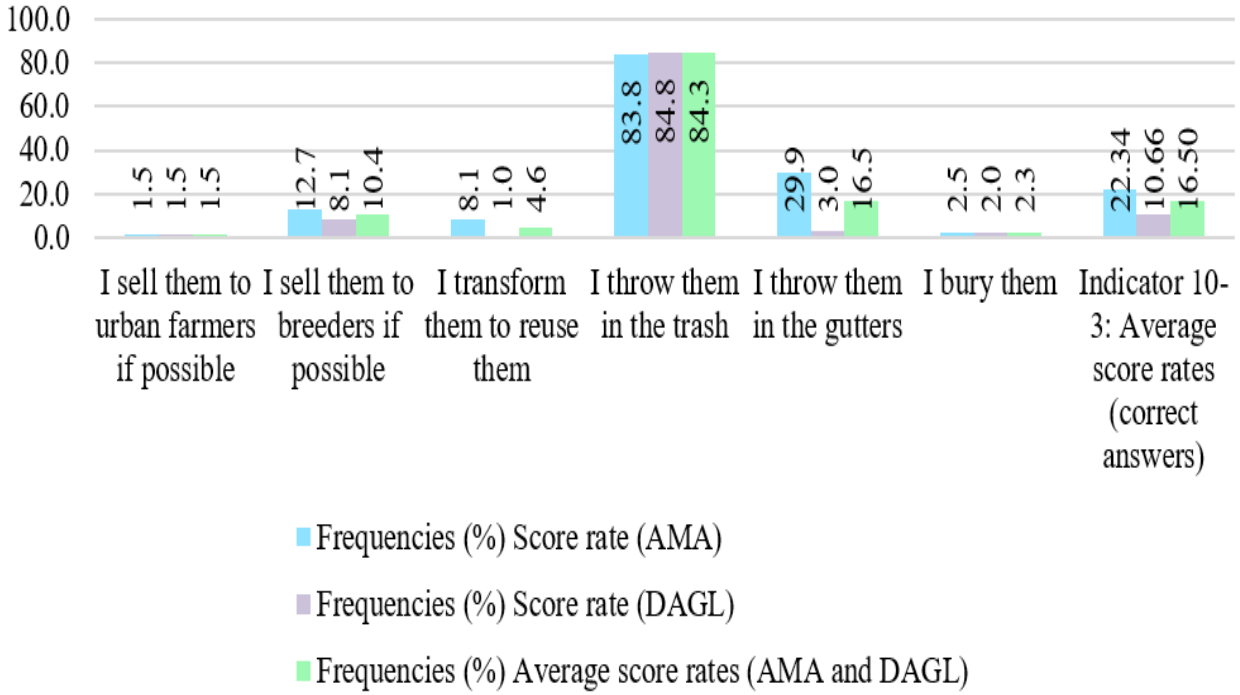

Figure 4.
Rate of good practice (Treatment of waste from vegetable preservation, preparation and post-consumption)
Source: K. E. Assinou and K. Kpotchou, 2024.

These graphs show that the ecological footprint linked to air, soil and water pollution (underground and surface) resulting from the dumping of vegetable waste (between 78.7% and 84.3%) may be high in the capital cities of Ghana and Togo, despite the fact that research has not measured it. This food detritus can also spread parasitic, bacterial and viral pathologies within these cities via vector agents. This depends on the tendency of 83.4% of those questioned to throw away rotten or spoiled food due to lack of preservation or protection.

This being the case, what about technological sustainability and public and civil society support for the proper use of vegetables in AMA and DAGL?

3.6. Deficiencies related to the use of ICT in access to vegetables and nutrition education in Accra and Greater Lomé: ecological, health and body safety risks

When it comes to the use of existing social networks and applications to purchase fresh vegetables or dishes made from these foodstuffs at least once (Figure no. 15), Loméans make very little use of social networks (13.20%) than Accra residents (61.42%). The same applies to ordering vegetables or food from mobile applications (Figure no. 15): 93.40% of Accra interviewees have used this method at least once; in contrast, only 20.30% of respondents in Togo's capital city have tried it at least once.

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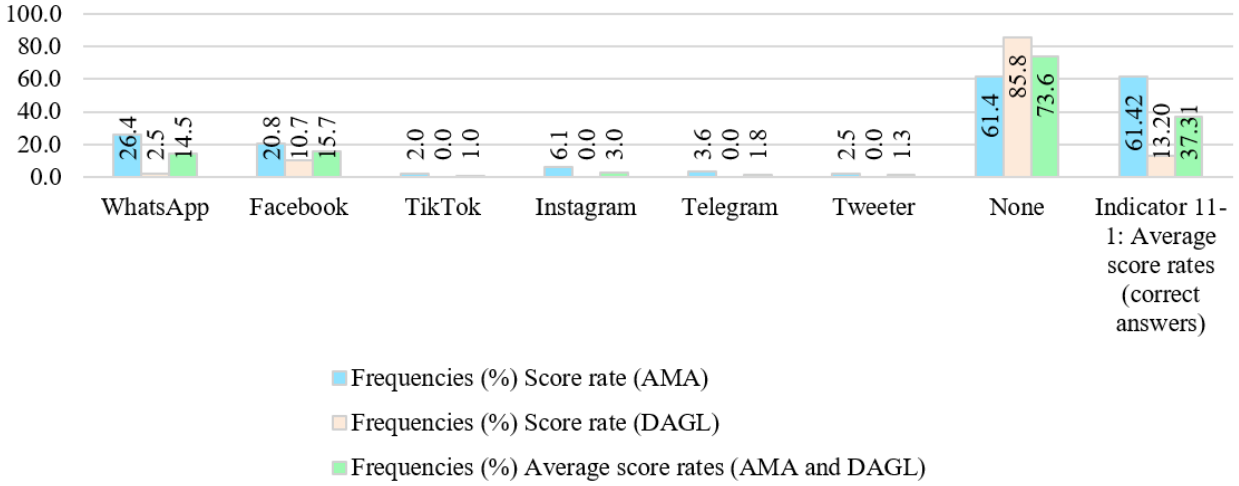

Figure 5.
Rate of use of Social Networks to order food or food.
Source: K. E. Assinou and K. Kpotchou, 2024.

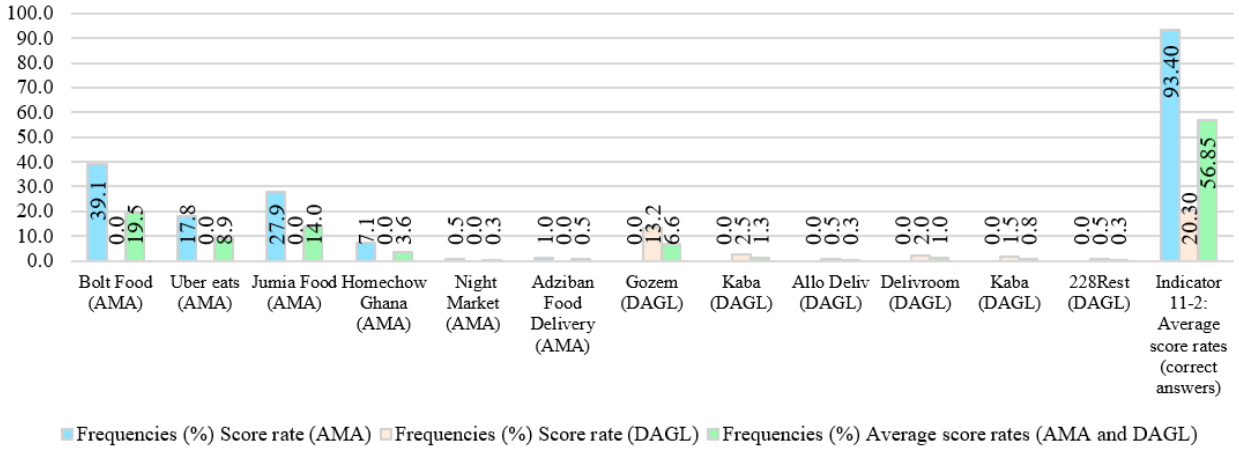

Figure 6.
Rate of utilization of mobile applications to order vegetables or food
Source: K. E. Assinou and K. Kpotchou, 2024.

These results imply potential costs in terms of time and energy wasted, without ignoring all the risks of road insecurity associated with consumer food supply mobility. It would also help reduce greenhouse gas emissions from motorized travel if online food ordering were 100% adopted. As Accra and Greater Lomé continue to grow in terms of population, it goes without saying that the demand for vegetables and the whole chain of activities involved create a growing use of energy linked to mobility, which is not necessarily green (high CO_2 emissions). If, for each household, we multiply this by the number of inhabitants and the number of errands required to supply vegetables over a day, a week, a month, a year or more, we can understand the scale of the ecological threat posed by these mobilities in the medium and long term, and even in the short term. The health risks associated with air pollution are not to be overlooked either.

Togo therefore faces a major challenge when it comes to designing and implementing projects or programs to educate people in the use of eco-friendly digital food sourcing tools. This is no less true for

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the need to revitalize food and nutrition education through the inclusion of all stakeholders at both territorial and national levels. Figures 17 and 18 illustrate the underlying reasons.

In Accra, as in Greater Lomé, the number of people who have once benefited from a public education project on sustainable food and nutrition is very low. On average (Figure n°17), this rate is 15.99% (22.84% for Accra and 9.14% for Greater Lomé). The situation is no better for NGO projects and programs on sustainable food and nutrition education (Figure n°18). Here, the average rate of participation in these projects by respondents is 6.60%, with Accra at 11.68% and Greater Lomé at 1.52%.

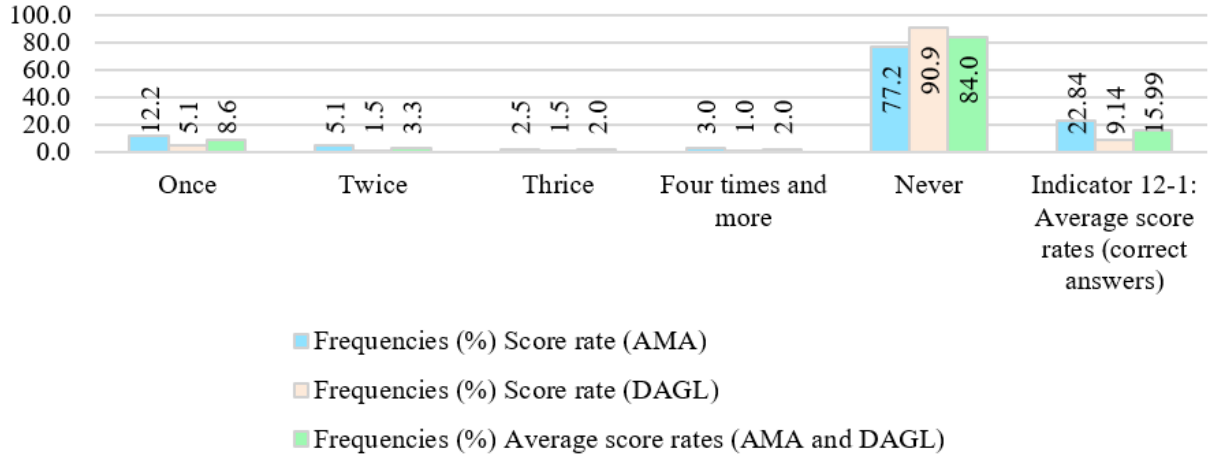

Figure 7.

Rate of participation of respondents in public projects related to food education and nutrition.

Source: K. E. Assinou and K. Kpotchou, 2024.

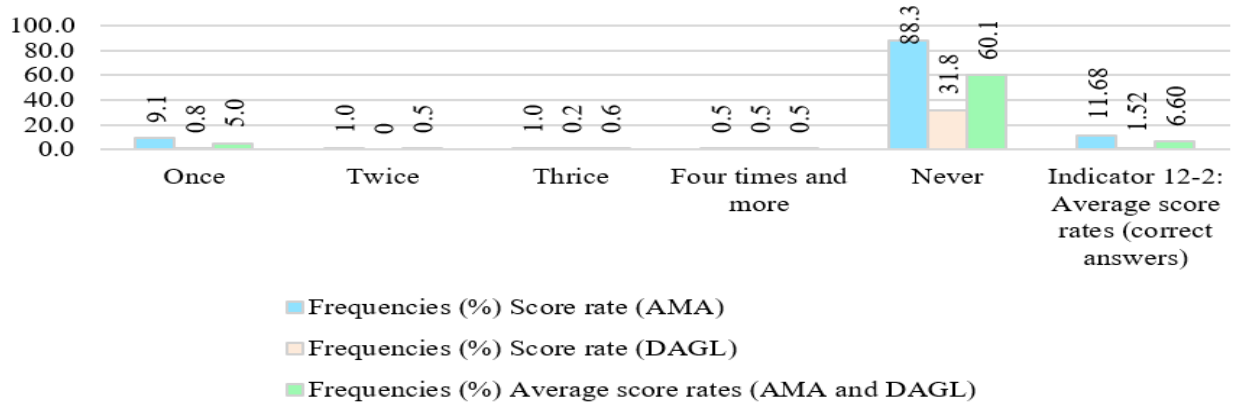

Figure 8.
Participation rate of respondents in NGOs and associations projects related to food education and nutrition.
Source: K. E. Assinou and K. Kpotchou, 2024.

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These results call into question the effectiveness of all the social actors involved in the socialization of food in Greater Lomé and Accra. These stakeholders have the potential to bring about lasting changes in the knowledge, attitudes and practices of consumers in the two conurbations. They include family, school, peer groups, health professionals, nutritionists, media, producers of dietetic research and documents, key players in the gastronomy industry, as well as urban planners and civil society organizations working in the field of food and nutrition security.

In view of the results, it is conceivable that the influences of the above-mentioned socialization bodies on the food and nutrition knowledge, attitudes and practices of food consumers in the two cities are asynchronous and less rapid than the lightning rapidity with which people's dietary lifestyles change at the consumption stage of food systems as at others. Under such conditions, the majority of inhabitants of the first cities of Ghana and Togo are far from being spared malnutrition related to the unsustainable use of food and the adoption of unhealthy diets as mentioned in the previous points of this research.

4. Discussion

The nutritional, health, ecological and socio-economic sustainability of Accra and Greater Lomé residents' vegetable knowledge and food practices is low; it stands at an overall average rate of 37.43% ($\bar{x}_{C\_AMA\_DAGL}$). In the Ghanaian capital, the rate is 45.64% ($\bar{x}_{C\_AMA}$), while it's lower in Greater Lomé (22, 22% $\bar{x}_{C\_DAGL}$). At first glance, the inhabitants of the capital cities of Ghana and Togo are far from respecting the principles of a sustainable diet due to the low rates linked to their knowledge and practices on the use of vegetables. The second United Nations Sustainable Development Goal (SDG 2) is therefore likely to be missed in these cities, and to have a major impact on the achievement of the other 16 SDGs. F.J. Chadare and al. (2022) l'ont confirmé dans leur recherche sur l'état de la nutrition en Afrique de l'Ouest par rapport à la réalisation des ODD.

In this regard, the discussion of the research findings focuses primarily on nutritional, health, environmental, technological and food safety implications, following the analytical logic of nutritional ecology theory (B. Bogin and al., 2018; D.J. Raiten and G.F.J. Combs, 2019; D. Raubenheimer and S.J. Simpson, 2016; D. Raubenheimer and al., 2009). It takes into account, to some extent, socio-economic, security and socio-political aspects. The discussion also draws on some Codex Alimentarius standards, the FAO guide to sustainable diets and Ghana's national nutrition guide.

From a nutritional point of view, in both Lomé and Accra, three facts with health and socio-economic consequences attract attention. The first is the doubt and superficiality of knowledge among city dwellers in both cities about the number of times vegetables need to be consumed in a day, and the low propensity to include this food family in the main meals of the day. Secondly, the doubt associated with the confusion that exists among food consumers in Accra and Greater Lomé is reflected in their propensity to eat vegetables. In both Accra and Lomé, only 13% of those interviewed claimed to eat vegetables at least 3 times a day. Thirdly, in both metropolitan areas, while 68.8% of respondents took the quantity of food to be consumed into account when allocating meals, gender and nutrient composition were only taken into account by 23.35% and 29.15% respectively. These data reveal the tendency of the target population to prioritize food satiety over the nutrient composition of meals, and the hedonic, physical, mental and psychological well-being of each individual as a function of socio-demoFigure variables such as gender and age. In addition, the low tendency of urban dwellers targeted by the research to consume vegetables in the numbers necessary for their health. The populations of the first urban agglomerations of Togo and Ghana are exposed to excesses, deficiencies and "dietary imbalances" from which chronic eating disorders can arise, as several research studies have already demonstrated (K.A. Ae-Ngibise and al., 2021; O.C. Aworh, 2024; F.J. Chadare and al., 2022). Women of childbearing age are essentially vulnerable to extreme fatigue, haematic insufficiency, bone loss, malformations in their children, and so on. For their part, children, especially those under five (5), are

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prey to wasting, underweight and stunted growth, as highlighted by P.E. Obasohan and al. (2020) in their research on risk factors associated with malnutrition among children under five (5) and in sub-Saharan Africa. From this research, it is understandable that beyond the socio-demoFigure status of populations, their access to drinking water, sanitation services, the young age of mothers, poverty or geoFigureal location (L. Casu and al., 2021; E.K.M. Darteh and al., 2017; A. Wemakor and al., 2018), malnutrition also depends on people's nutritional knowledge and practices. Indeed, the less vegetables they eat, the harder it is for them to supply their bodies with the vitamins, minerals, proteins and fibers they need to keep their organs functioning properly, maintain good health and lead permanently active lives (Y. Dijkxhoorn and al., 2021; A.W. Ebert, 2020; J. Harris and al., 2022). The research results also contradict the diet principles recommended by the Food and Agriculture Organization of the United Nations (FAO/OMS, 2020, p. 11-13). The same is true of Ghana's nutritional guide to adopting the right diet (MFA/GSPH, 2023).

In this situation, it is doubtful whether SDG 3 can be achieved in these two cities, since a malnourished population can only be weakly productive due to its fragile health (S.A.O. Adeyeye and al., 2023; L.E. Bain and al., 2013). And a population with a high proportion of working-age but low-productivity young people puts everyone at a disadvantage when it comes to earning an income that will enable them to meet their most basic needs (R. Nugent and al., 2020). Malnutrition can keep the majority of young people in Greater Lomé and Accra in poverty, which is why these cities have little chance of achieving the MDG1 target by 2030. Nor is this reality conducive to achieving the 2030 global agenda's SDGs 8 and 10 (difficulty of access to decent IGAs and widening gaps in socio-economic inequality). However, existing research has come to the conclusion that socio-economic inequalities, in a context of growing insecurity in West Africa with terrorist threats, can facilitate the radicalization of young people and unbalance social and physical peace, which would act negatively on the realization of SDG16 too (S.A.O. Adeyeye and al., 2023; C.C. Onyeneke and A.H. Karam, 2022).

From the point of view of food, health, ecological and socio-economic insecurity in relation to the high percentage of respondents who, for the most part, are unaware of the disadvantages of harmful vegetable preservation on their quality, availability, accessibility and their own health in the capital cities of Togo and Ghana, four key points are addressed. They concern food losses, nutrition-health risks, eco-sanitary threats and socio-economic dangers linked to poor conservation and unhealthy management of waste from vegetable handling.

With regard to food waste and nutrition-health risks (Figure 12 and 13), consumers in both cities are more likely to throw away rotten (84.3%) or decaying vegetables (78.7%) than to seek to process them for reuse (4.6%), which is not necessarily for food. However, in sub-Saharan Africa, both at the individual, household level and that of food supply actors, in general, control of socio-technical, material, financial and technological resources is weak when it comes to the non-harmful preservation of foodstuffs, including vegetables (E.A. Shrimpton and N. Balta-Ozkan, 2024). Meanwhile, the cities surveyed are growing almost uncontrollably. This situation may hamper the availability of vegetables in sufficient quantities to meet the fresh vegetable needs of Lomé and the inhabitants of Ghana's capital. This can be a factor in the emergence of difficult access to these foodstuffs for these city dwellers, since most of them do not necessarily have the financial or material means to travel and/or buy them in the event of shortages. This raises a significant problem of nutritional insecurity: difficult access to vegetables is a corollary of undernourishment and malnutrition. What's more, this nutritional insecurity is reinforced by the fact that in both towns, a small proportion of respondents are aware of the micronutrient (24.4%) and macronutrient (19%) losses associated with poor vegetable preservation (see Table 10). Nevertheless, it is irrefutably obvious that a population suffering predominantly from undernourishment or hidden hunger is a population prone to a number of food-deficiency diseases and, by extension, to unstable health. Nor does this situation make it any easier to achieve the United

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Nations' second and third Sustainable Development Goals (SDG2 and 3) by 2030. Furthermore, an urban youth population in poor health cannot be productive to the point of creating wealth.

As regards the ecological aspect associated with human, animal and plant health, in relation to the difficulty of managing waste from vegetable handling within these two cities, aquatic (surface and groundwater), terrestrial and wind ecosystems can be confronted with significant pollution that can affect the health of any animal or plant species without ignoring that of humans. This depends on the fact that from 78.7% to 84.3% of consumers adopt the practice of throwing away decomposing or rotting vegetables: the overall average rate of city dwellers in Greater Lomé and Accra who opt for good vegetable preservation practices is only 36.80% (average of data from Figures n°11, 12 and 13). Moreover, the good recommendations associated with the management of decomposing vegetables are adopted by only 2.54% of respondents. The same cannot be said for the percentage of respondents who manage vegetable handling waste responsibly (16.5%). As far as animal and plant health is concerned, the decomposition of discarded food can lead to biochemical reactions unfavorable to the well-being of animals, and even microorganisms living in all ecosystems (water, soil, air). It can also lead to the spread of certain viral, parasitic or bacterial pathologies via human or animal vectors. These facts do not contribute to the protection of aquatic ecosystems ("SDG14") or terrestrial ecosystems ("SDG15"), nor to the achievement of SDG12. Nor do they reflect consideration of hygiene and health principles relating to the sustainable use, handling and consumption of vegetables (FAO/WHO, 2017, 2022). Thus, the sustainability of human settlements and urban centers (SDG 11) as well as responsible consumption (SDG12) are threatened in terms of achieving the UN's 2030 agenda.

The socio-economic component of the discussion of results, as indicated above, focuses on the indirect consequences of undernourishment for the economic productivity of urban dwellers in both cities. In view of the results, it is first and foremost evident that the risks of exposure of interviewees to hidden hunger, undernourishment, dietary and nutritional excesses, dietary and nutritional imbalances and food poisoning are significant in terms of health pathologies (S.A.O. Adeyeye and al., 2023). For example, energy deficiencies often lead to marasmus; protein deficiencies are the main source of kwashiorkor; and avitaminoses C, B1, A and D can cause scurvy, beriberi, skin lesions and rickets respectively. Mineral deficiencies linked to iodine, iron and calcium are also potential sources of goitre, hematic pathologies and bone fever. Additional consequences of overnutrition and fatal food poisoning include the development of cancer, diabetes, overweight and obesity. However, it has been found that people living in West African cities, including Greater Lomé and Accra, are more prey to these diseases due to their diets excessively rich in sugars, saturated fatty acids and salts (K. Abass and al., 2017; S. Agyei-Mensah and A. de-Graft Aikins, 2010; K.C. Kouassi, 2021). Faced with such health facts, which constitute real public health problems, the stability of the working population's productivity in the cities of Togo and Ghana is not a certainty. As a result, the risks of vulnerability and poverty can intensify, with low purchasing power and major difficulties in satisfying vital needs, starting with food itself, housing, individual and public sanitation, economic and physical access to healthcare and education, and so on. This vulnerability can further create social inequalities and facilitate the radicalization of the social strata most exposed to violent extremism, which continues to gain ground in sub-Saharan Africa. This also poses the challenge of strengthening support for initiatives to secure goods and people within the cities targeted by the study, without ignoring their outskirts.

More worrying is the very low proportion of respondents who have already benefited from sustainable food education programs and/or projects, either run by public institutions and services, or by civil society organizations. Indeed, for Accra and Greater Lomé taken together, the average rate of respondents having accessed such projects or programs at least once is 7.29%. What emerges from this is that the ignorance of the majority of city dwellers in Accra and Greater Lomé in terms of nutrition and sustainable food constitutes a bottleneck whose influence on the achievement of the Sustainable Development Goals is undeniable, if not appreciable. This situation runs counter to the strategies, plans,

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projects and programs to make the food systems of the main cities of Togo and Ghana viable. Mechanisms for strengthening food and nutrition policies in these countries need to be reinforced, both through their territorialization and through ongoing, inclusive education in sustainable food and nutrition, with particular emphasis on the knowledge and responsible use of vegetables.

5. Conclusion

The assessment of the nutritional, health, ecological and socio-economic sustainability of the levels of knowledge and good practices of the inhabitants of the first urban agglomerations of Ghana and Togo on the use of vegetables was carried out through a quantitative multi-criteria approach supported by purposive sampling around 394 respondents. The research showed that respondents had insufficient or low levels of knowledge and recommended dietary practices with regard to vegetable consumption. This overall rate calculated at 36.93% ($\bar{x}_{C\_AMA\_DAGL}$) reveals that around 62% of the inhabitants of these cities are unaware of the importance of vegetables in terms of their nutrient intake, and expose themselves to the threat of numerous pathologies associated with nutritional deficiencies, which can in turn affect their health, quality of life and socio-economic productivity. Nor are these results far from obliterating the ecosystemic balance of these cities, acting negatively on animal and plant well-being while slowing their economic and social momentum in terms of reducing their inhabitants' ability to meet their basic vital needs. This makes these city dwellers vulnerable to extremist radicalization. These results highlight the potential difficulties that Accra and Lomé may have in achieving the SDGs, given the remarkable imperfection that characterizes them in terms of food and nutrition education (92.71%). It is therefore important to set up a permanent, inclusive and integrated food and nutrition education program to promote access for all to a healthy, sufficient, nutritious, sustainable diet that gives significant consideration to vegetables.

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Authors' contributions:

ASSINOU Kokou Elom: Project administration; Conceptualization; Methodology, software, investigation, Data curation, writing—original draft, analysis, validation.
KPOTCHOU Koffi: Supervision, Conceptualization, writing—review, validation
All authors have read and agreed to published this version of the manuscript.

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