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Ecological Footprint of Food Consumption in Ijebu Ode, Nigeria

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ABSTRACT

A recent study establishes that since 1970, there has been an ecological gap between human needs and the planet's resources, with annual resource demand exceeding the bio-productivity of the planet. Specifically, humanity utilises equivalent of 1.75 earths to produce the ecological resources used, with half of this attributable to food consumption. The present work therefore seeks to provide an empirically-based insight into the environmental sustainability of the EF of food consumption in Ijebu Ode. A descriptive cross-sectional approach was used, and primary data were collected from 400 systemically sampled households via structured questionnaires and analysed descriptively using Microsoft Excel and inferentially using mathematical models for calculating ecological footprints. Findings revealed that the household EF of food consumption in Ijebu Ode is 0.05gha per capita, with the footprint of cereal consumption (0.17gha; 37%) taking the major share, followed by meat with a footprint of 0.11gha (23.9%). As a result, it was concluded that Ijebu Ode has sustainable food consumption, which is necessary for its environmental sustainability. However, the sustenance of the former requires creating awareness of the need for sustainable consumption and prioritisation of integrated and population-wide policies and food intervention initiatives to encourage attitudinal change in favour of sustainable food consumption while fostering sustainable food production strategies amidst current environmental realities.

Keywords: *Ecological footprint, Food, Food footprint, Food consumption, Sustainability.*

1. Introduction

Sustainability, or ensuring that everyone live comfortably within the limit of nature, depends on ensuring we do not utilize more ecological services than nature can renew [1], however, according to the recent World Wildlife Fund's (WWF) report, the aggregate consumption of natural assets globally has been overused by 56% while planet's natural assets has reduced by over 68% since 1970 [2], while humanity global population has risen by 121% from the same year [3]. As a result, humanity is consuming more than the renewing capacity of nature. For instance, it has been established that since 1970, there has been an ecological gap between human needs and the planet's resources, with annual resource demand exceeding the bio-productivity of the planet. Specifically, humanity utilizes equivalent of 1.75 earths to provide the natural resources used, with half of this attributable to food consumption [4].

Ecological footprint (EF) has been found to be the ideal tool for assessing this trend in human consumption [5], and it is regarded as a tool that is more statistically effective in the computation and assessment of resource generation and usage when presenting sustainability in quantitative terms [6]. As a strategy for environmental sustainability, EF therefore maintains a balance between bio-productive areas and the degree of resource utilization [7],[6], and according to Global Footprint Network (GFN) [8], "Ecological footprint is the only metric that measures how much nature we have and how much nature we use."

In actuality, resource use rather than production today poses the greatest threat to environmental assets. The current paradigm shift is that consumption is now the source of environmental issues rather than production [9]. It has been demonstrated that production depends on consumption, and human activities are dictated by consumption because

it is dependent on the lifestyle that households embrace. Consequently, this necessitates a change from sustainable development to sustainable consumption [9].

Accordingly, sustainable consumption calls for the responsible use of ecological assets as well as observing and living within ecological limitations, as going over these limits and failing to live within them will result in the destruction of humanity's one and only place on Earth [10]. According to studies [11],[12], consuming food, which is primarily produced through agricultural activities, accounts for approximately 30% of anthropogenic greenhouse gas (GHG) emissions. The gravity of this issue is amply illustrated with estimations for Germany, where food contributes to roughly 16 percent of GHG emissions, the same share as transportation [13], and the UK, where food consumption and production contribute to about 18 percent of GHG emissions [14]. Furthermore, these issues are only anticipated to become more pronounced in the future due to demographic shifts and the expanding world population [15].

Nevertheless, studies have shown that in attempting to feed a growing global population in the future, agricultural production will need to be expanded even in the absence of these shifting consumption habits. For instance, the World Bank [16] estimates that between 2000 and 2030, the production of meat will need to expand by 85% and that of cereals by 50%. However, experts believe that cutting back on meat (especially beef), preferring vegetables and fruits, and avoiding exotic goods on a personal and institutional level are the best approaches for wealthy societies to lessen the ecological impact of their consumption [17]. In light of this, a mounting body of literature suggests that plant-based foods, which are based primarily on fruits, vegetables, legumes, and cereals, have a better influence on health and a less negative impact on the environment than animal-based dietary patterns [18]-[20]. Nonetheless, these results must be examined through a situation-specific lens in order to account for regional and local variances in agricultural techniques, environmental resources, local food processes, and cultural preferences of varied communities [20].

Therefore, the sustainability of food consumption involves more than just health issues because it also considers the impact on the environment [21],[22]. As a result, to ensure the sustainability of our diminishing natural resources, it is necessary to lessen the pressures that food consumption places on natural assets globally [23], and given the growing demand for resources, it is also important to address consumption footprints, particularly in industrialised nations [24],[25], and globally at large.

However, though the importance of the food domain for sustainability policies is now widely acknowledged, nothing is being done to build a holistic sustainable development policy that addresses all players in the food sphere [15]. This may be inhibited by insufficient data collection and concise summaries of the negative effects of unsustainable consumption on the environment and human health, given that most studies only address one aspect of sustainability, leaving room for uncertainty regarding the magnitude of potential effects [26]. Such an assessment (like the EF of food consumption) can provide people and decision-makers with important data and a basis to investigate ways of managing natural capital more effectively.

As a result, the object of this study was to appraise the ecological footprint (EF) of Ijebu Ode's food consumption. While it is empirically obvious from all EF studies that food is a significant component, only a small number of

studies have investigated and analyzed the food footprint in Nigeria. The results of this study are therefore expected to be a major policy driver for interventions in sustainable development, particularly to raise awareness of and priorities integrated, population-wide policy initiatives aimed at encouraging sustainable consumption and reducing our use of natural resources and, consequently, our ecological footprint.

2. Materials and Methods

2.1. Study Area

The study was conducted in Ijebu Ode, located about 60 kilometers northwest of Lagos and the second-largest city in Ogun State, in the south-west of Nigeria, with a land area of 192 km^2 and a population estimate of 154,032 [27], (Fig.1). Currently, according to the World Population Review [28], Ijebu Ode has a rapidly expanding and widely dispersed sub-urban region, with an estimated current population of 367,749 and a population growth rate of 3.36% (fig.2). Ijebu-Ode lies within the tropical lowland rain forest zone and is situated at around 7^0N latitude, and experiences a variety of meteorological conditions, including dry and rainy climates, with mean annual rainfall of between 1523 mm and 2340 mm, and an average temperature range of 25°C and 32°C [29]. Cassava, maize, yams, oil palm, and oranges are just a few of the key crops grown by the locals, while timber and rubber have also become significant regional exports [30]. According to recent estimations, Ogun State, the parent state of the study area, produces between 15,000 and 20,000 tonnes of rice annually [31], with a cultivation area of roughly 12,000 hectares, accounting for about 0.7 percent of the country's total rice-growing land [32].

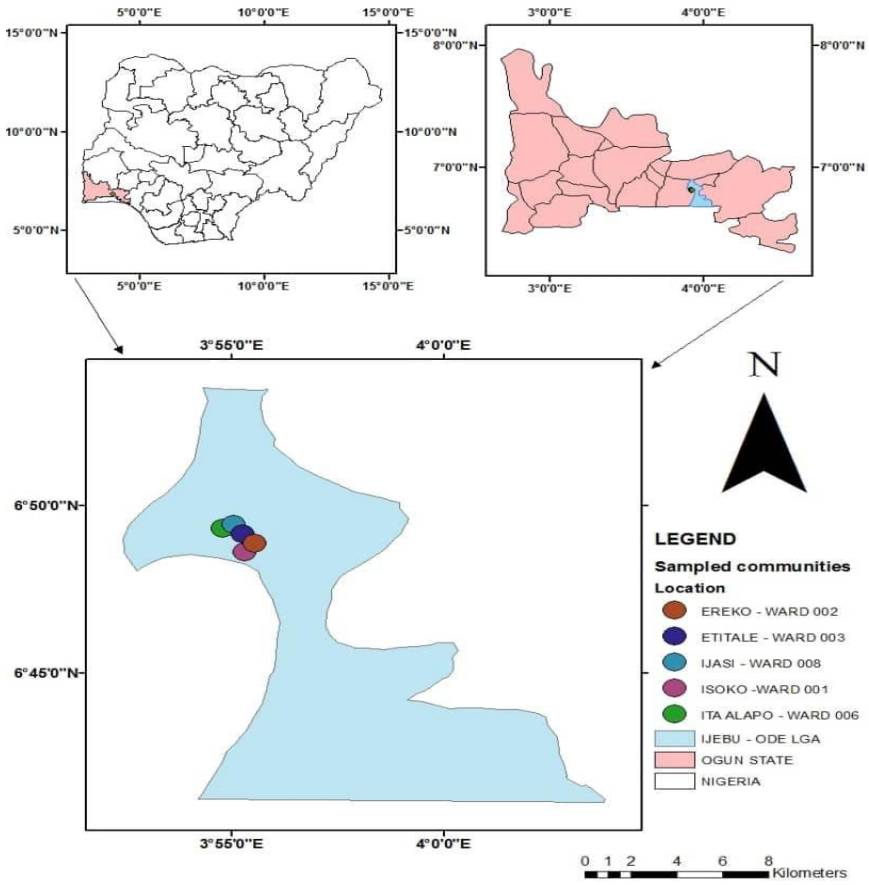

Fig.1. Sampling Locations, Ijebu Ode [33]

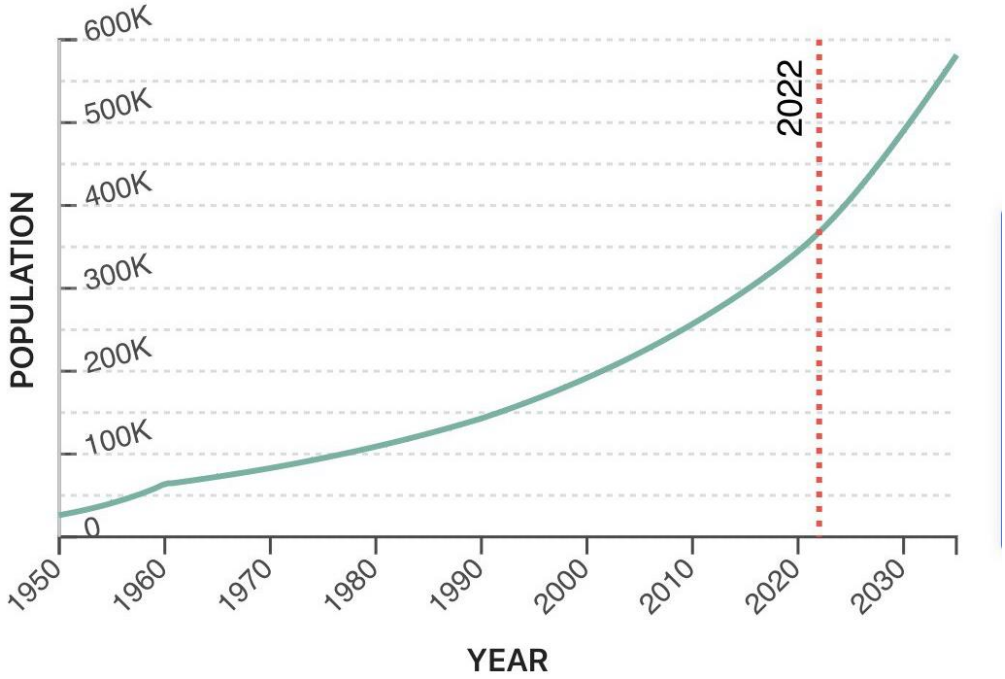

Fig.2. Ijebu Ode Population 2022 [28]

2.2. Samples and Sampling Techniques

Simple random sampling was employed in the selection of five (5) wards from a total of eleven (11) wards in Ijebu Ode, with eighty (80) respondents drawn from each ward to make up the necessary four hundred samples. A systematic random sampling technique was then used to select residential households in each of the selected wards at intervals of every fifth home.

Slovin's technique for determining sample size (eq.1) was adopted to estimate the sample size of 400 respondents for the study, with a 0.05 error margin and a 95 percent confidence interval [34];

$$n = \frac{N}{1 + e^2} \qquad (1)$$

Where;

n = sample size

N = population size

e = margin of error

2.3. Data Collection Procedure

The primary data for this investigation was provided by a structured questionnaire that was distributed to a systematic sample of 400 households. The primary data comprises 400 household questionnaires, which were used to gather data from research participants in the five chosen wards of Ijasi/Idepo, Itantebo/Ita Ogbin, Odo/Esa, Porogun I, and Isoku/Ososa of the Ijebu Ode LGA about their food consumption and expenditures. Additional sources of secondary data included the Global Footprint Network, Food and Agriculture Organization, National Bureau of Statistics (NBS), and various online publications (table 1).

Table 1. EF Data Requirements and Sources

S/n	Data	Source
1	Socio-demographic Data	Author's Field Survey
2	Population (Ijebu Ode)	NBS, 2007
3	Food Consumption Data	Author's Field Survey
4	Equivalence Factor	GFN, 2019
5	Yield Factor	GFN, 2019

2.4. Data Analysis Approach

Data for the study were computed and analysed descriptively in Microsoft Excel using distribution tables with simple percentages, as well as inferentially using mathematical models for ecological footprint calculation, while spatial data were analysed in ARC-GIS and the results were visualised using charts.

2.5. Estimation of Food Consumption EF

The footprint of some major food categories consumed in Ijebu Ode, including cereals, beverages, fruit, meat, fish, vegetables, and chicken/turkey, was determined (fig.2). From the empirical survey, the total amount of food consumed annually was estimated. This value was translated into consumption in kilogrammes by dividing the yearly cost of consumption with the average cost of 1 kilogramme of food from the market survey, which in this case is 420 Nigerian naira (Field survey, 2021). By dividing the consumption in kilogrammes by 1,000, it was also converted to consumption in tonnes. Following that, the footprint in global hectares was estimated by dividing the consumption in tonnes by the national yield factor of cropland (0.88) and multiplying the resultant value with the equivalence factor (2.52) and the embodied energy of food consumed in tonnes. Thus, the EF per capita was determined by dividing the global hectare footprint with the 154,032 inhabitants of Ijebu Ode [27]. This results in the global footprint in hectares per capita as indicated in Eq.2 [35]:

$$EF_f = \sum_1^7 \frac{C}{Y_c} \times E_f \times EE \qquad (2)$$

Where;

EF_f = EF of food (gha/capita);

C = food consumption in tons;

EE = embodied energy (MJ/kg); and

Y_f and E_f = yield and equivalence factor

3. Results

The major foods needed to ensure health and survival in the household surveys were itemised into the following categories: cereals, meat, chicken/turkey, fish, eggs, beverages, vegetables, and fruits, as shown in Fig.3. The EF

analysis of the various food categories reveals that cereals have the highest EF with 0.17gha (37%), which was followed by meat with 0.11gha (23.9%), and fish with 0.07gha (15.2%). Also, the EF of chicken/turkey consumption is 0.04gha (8.7%), vegetables are 0.03gha (6.5%), beverages are 0.02gha (4.3%), and eggs and fruits are 0.01 (2.2%), according to the analysis. However, the overall EF of food consumption was revealed as 0.05 gha per capita.

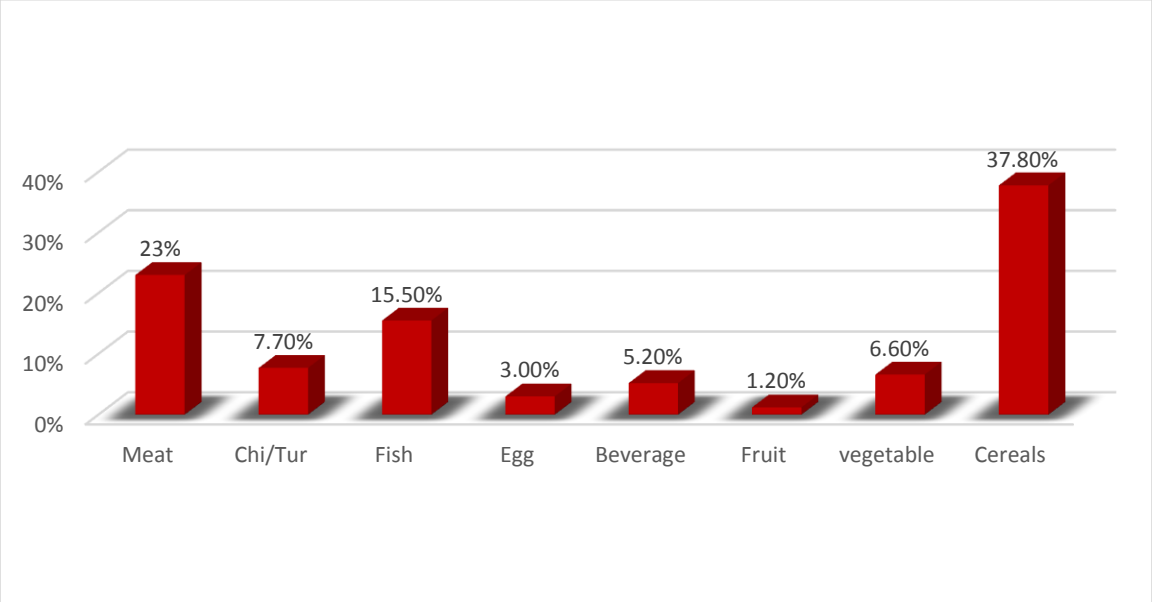

Fig.3. Percentage distribution of annual food consumption by categories

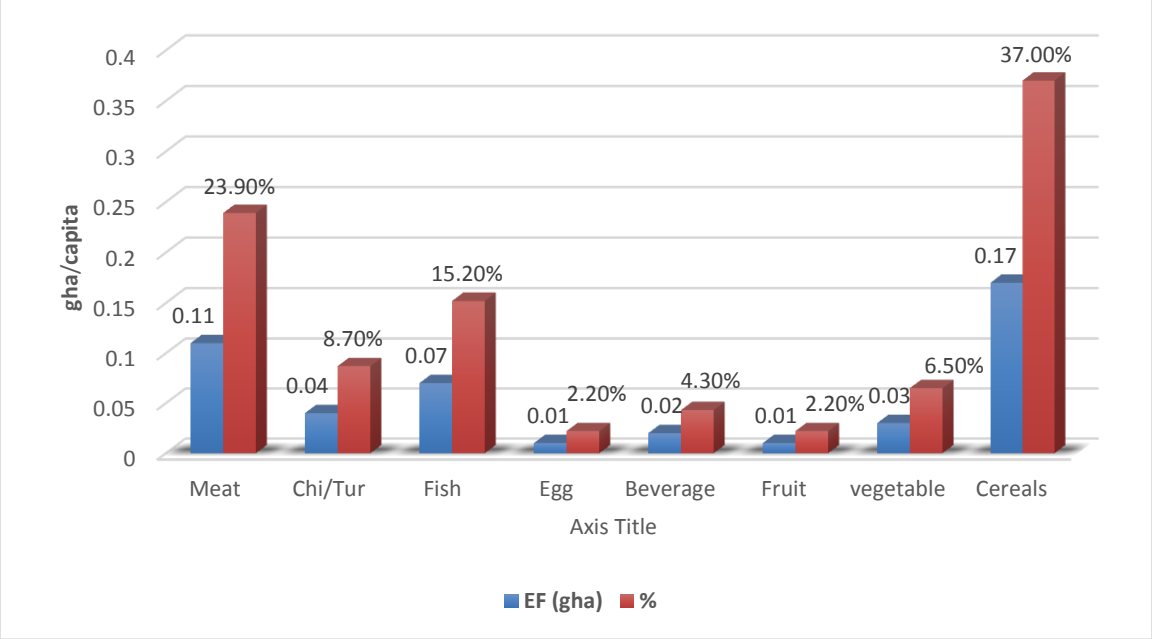

Fig.4. EF of various food categories and their percentage distribution

4. Discussions

The investigation was concerned with the ecological footprint assessment of food consumption in Ijebu Ode. Findings indicated that the overall EF of food consumption is 0.05 gha per capita, which constituted less than 5% of

the general EF of Ijebu Ode. This, however, indicates sustainable food consumption. Generally, any footprint calculation of more than one (1) implies unsustainable consumption of resources [36]. The result may be explained by the obvious fact that most residents relied on their locally grown food as their major source of consumption. For example, according to Okojie et al. [37], the majority of Ogun state's rural households (75.5%) acquire their food through self-production, which is usually home-grown food. Similarly, according to reports, more than 60% of the population, particularly those in low-income categories, rely on locally produced foods [38]. It has also been documented that locally grown food items are healthier than processed food items imported from overseas that have the likelihood of increasing the EF [39]. Another possible explanation for the results may be the reduced meat consumption, with only 23.9% of the aggregate food footprint, which may be owing to the high price of meat occasioned by the current economic state of Nigeria. Several studies have found that a significant increase in meat consumption resulted in a significant increase in the EF relative to GHG, which are precursors of climate change [10],[40]-[43]. The present result is in confirmation with a prior study by Fadeyibi et al. [35], which also reported sustainable food consumption in the Ilorin Metropolis, with a food EF of 0.02 gha/capita (5%) of the total Ef of Ilorin. In contrast, a similar study in Bida found that food footprint accounted for the majority of Bida's EF (57.25%) [5]. This was possibly due to high demand for processed food, which was reported to be at a proportion of 76%, and according to Abd'Razack et al. [44], highly processed and packaged foods have a high impact on the EF.

Further analysis of the various food consumption patterns revealed that cereals have the highest EF, accounting for 0.17gha (37% of the total food footprint) (Fig.4). This can be explained by the point that cereals form the baseline of staple food consumption and are locally available and accessible, with high affordability. Chiaka et al. [45] in a study on the consumption pattern of food in the six geopolitical zones established that cereals and starchy roots contribute hugely (above 70%) to household calorie needs in Nigeria, particularly the South-west, which had the highest cereal consumption, especially rice. One possible explanation is that the south-west has many rice-producing states, which may have influenced rice prices to be lower than in other parts of the country [31]. Moreover, cereals have been suggested to have a low environmental impact [46] and lower ecological footprints [47]. This finding is in agreement with similar work by Fadeyibi et al. [35], whose results revealed that cereal had the highest footprint (0.01 gha), which, according to them, was probably because of the high demand for cereal due to high consumption of pap, which is primarily made from cereals. The current work is also in confirmation of previous observations by Shakil & Muhammed [48] and Zhen & Du [43], who both reported the food footprint of cereal consumption as being the highest. Earlier studies have documented that cereals, in contrast to meat and animal-based foods, contribute relatively low levels of GHG emissions [18, 19], which promotes sustainable consumption. However, the current findings contradict the work of Lin and Binzhen [49], who documented cereals as second only to meat in Guyuan's EF share, a result that was largely due to the integration of grain into the green program, which resulted in a reduction in cereal cultivation due to a significant decrease in cultivated farmland in Guyuan.

In addition, findings also demonstrated that meat has an EF of 0.11 gha (23.9%), which was second only to cereal in Ijebu Ode's EF share of food consumption (Fig.4). This may be as a result of the high price of meat from the current economic travails in the country, which may have influenced their demand for alternative sources and high demand

for staple food, which is carbohydrates, as reflected in the high footprint of cereal consumption (Fig.4). According to Reisch et al. [17], food preferences are shaped by many factors, among which are finances and time, but price, in particular, is a key decision criterion. The low meat consumption, however, may have influenced the overall sustainable EF of food consumption, vis-à-vis environmental sustainability. For instance, a study has reported that a decrease in EF was generally proportional to the extent of animal-based food limit [26], and similarly, most studies found that food containing less meat resulted in a significant decrease in global GHG emissions [40], [50], [51]. The finding of the current study is consistent with an earlier work by Fadeyibi et al. [35], whose report revealed meat consumption as the second main contributor to the food consumption footprint in the Ilorin Metropolis.

Additionally, further analysis of other food components showed that vegetables (0.03gha; 6.5%) and fruits (0.01gha; 2.2%) have the lowest consumption footprint (Fig.4), which is suggestive of the low taste of the residents for fruits and vegetables. The latter, which is only consumed during the preparations of the various traditional soups in the household, A study by Okojie et al. [37] on household consumption patterns indicates that Ogun State rural-households consumed mostly carbohydrates (particularly cereals), and consumed fewer fruits, vegetables, and protein sources. From the ecological standpoint, it has been suggested that increasing vegetable consumption and less animal-based food consumption reduces the EF and thus the use of natural resources [52]. Similarly, studies have suggested that vegetables and fruits, in contrast to other food components, contribute relatively low levels of GHG emissions [18],[19]. Moreover, the current results are in line with prior work which identified vegetables and fruits as having the lowest EF of the aggregate EF of food in Ilorin Metropolis [35]. Also, the findings are substantiated by Leclercq et al. [53], who documented that adult Italians consume much less fruit and vegetables than the suggested consumption.

The current findings have provided an empirically-based insight into the EF of food consumption, which can serve as a key environmental sustainability policy driver for sustainable consumption intervention, particularly increasing vegetable consumption and reducing animal-based food consumption to minimise ecological footprint and thus the use of our natural assets.

However, our study did not consider the potential impact of food consumption on the EF of water and GHG emissions (carbon footprint), as well as the challenge of data accuracy, since in a survey of this nature, households may either overvalue or undervalue their food expenditure, as participants also often misreport or fail to recall their actual consumption patterns, especially for food taken outside. As a result, it is important, therefore, to examine the environmental sustainability of the EF of food consumption, taking into consideration simultaneously the water and carbon footprint potentials of food consumption, as well as multidisciplinary investigative studies for a more holistic evaluation of the EF of food consumption in Ijebu Ode.

5. Conclusion

The present work seeks to provide an empirically-based insight into the environmental sustainability of the EF of food consumption in Ijebu Ode. The findings revealed that households' EF of food consumption in Ijebu Ode is 0.05gha per capita, with the footprint of cereal consumption (0.17gha; 37%) being the major contributor, followed

by meat with a footprint of 0.11gha (23.9%). The lowest of the EF of food consumption were vegetables and fruits, with 0.03 gha (6.5%) and 0.01 gha (2.2%), respectively. As a result, we therefore concluded that Ijebu Ode has sustainable food consumption, which is necessary for its environmental sustainability. However, the sustenance of the former requires creating awareness of the need for sustainable consumption and prioritisation of integrated and population-wide policies and food intervention initiatives to encourage attitudinal change in sustainable food consumption while fostering sustainable food production strategies amidst current environmental realities.

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Declarations

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Competing Interests Statement

The authors declare no competing financial, professional, and personal interests.

Ethical Approval

Based on institutional guidelines.

Consent for publication

Authors declare that they consented for the publication of this research work.

Availability of data and material

Authors are willing to share the data and material according to relevant needs.

Authors' Contributions

All authors equally contributed to data collection, research, and paper drafting.

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