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**DESCRIPTIVE ANALYSIS OF CHANGES
IN GHANA'S FOOD AVAILABILITY AND FOOD SAFETY INFORMATION
BETWEEN 2010 AND 2020**

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ABSTRACT

Access to safe, nutritious, and sufficient food is essential to ensure food and nutrition security and healthy lives for all. Secure access to nutritious food ensures healthy eating habits, economic growth, and stability in an economy. However, food insecurity and malnutrition persist globally. In Ghana, more than half of food-insecure people reside in the Northern ecological zones of the country. Moreover, Ghana lacks a systematic food security monitoring system to track food insecurity among vulnerable populations. This study reviewed existing evidence on the current situation and changes related to food production, trade, safety, and consumption in Ghana, as part of the process to develop food-based dietary guidelines for the country. The literature review included peer-reviewed articles published from 2010 – 2020 in Ghana to document household-level food production, consumption, and safety issues. In addition, food disappearance data (from 2010 to 2018) from the Food and Agriculture Organization of the United Nations was analysed. Means and compound annual growth rates were calculated for each food item included. The results showed that per capita food production was higher than per capita consumption in all the food categories studied, except for vegetables, and fish and fishery products. Food consumption was centred on a few priority staple crops such as cassava, maize, rice, and yams, with less consideration given to underutilised foods such as *akokono* (palm weevil larvae). Food imports exceeded food exports in all food categories except 1) cocoa beans and products, 2) root crops and tubers, 3) oil-bearing crops and nuts, and 4) fruits and products. Fruit and vegetable consumption in Ghana has been declining since 2013. There was also a rise in the import and consumption of processed foods, especially tomato paste, sugars, and alcoholic and non-alcoholic beverages. Food safety issues included microbial contamination, aflatoxin contamination, polycyclic aromatic hydrocarbons in smoked fish, mercury in fish, pesticide and heavy metal residues in vegetables and fruits, and food adulteration. The evidence synthesized from this study will be useful to inform the development of food-based dietary guidelines for Ghana.

Key words: Food, production, trade, consumption, food security, safety, Ghana

INTRODUCTION

In 1996, the Rome Declaration on World Food Security highlighted food availability, accessibility, and utilisation as the three dimensions of food security [1]. Food availability includes producing, distributing, and exchanging food, whilst food accessibility entails acquiring food. Food utilisation has a central element of food safety and includes consuming and deriving benefits from food [1]. The stability of these three dimensions is central to attaining food security. Moreover, failure to meet any of these three dimensions leads to food insecurity. Food insecurity and hunger are closely related and have simultaneously been monitored [2].

Yet, the prevalence of hunger has been increasing since 2014 globally, with one out of ten people suffering from severe food insecurity [2]. Lack or limited access to nutritious, diverse, and healthy foods supports unhealthy eating habits [3]. The current COVID-19 pandemic threatens food security because an additional 132 million people may be malnourished in 2020 [2]. Moreover, factors such as global economic growth may influence the uneven distribution of the projected undernourished people [2]. The uneven distribution of undernourished people may hinder a country's ability to achieve the hunger, food security, and nutrition targets under Sustainable Development Goal two.

In Ghana, the number of severely and moderately food insecure people rose from 13.6 million between 2014 and 2016 to 15.2 million between 2017 to 2019 [2]. It is not surprising that food insecurity is a national concern prioritized by sectors such as food and agriculture [4]. Yet, there is limited systematic food insecurity monitoring at the national and household levels in Ghana. The World Food Programme carried out the first and only national comprehensive food insecurity monitoring in 2009 [5], followed by a second Comprehensive Food Security and Vulnerability Analysis in 2012, but only focused on the northern ecological zone of Ghana [5].

Food balance sheets have been central to national food security monitoring to measure trends in famine, food supplies, and malnutrition. Food balance sheets are standardised and updated regularly to enhance the comparison and analysis of trends over time [6]. Therefore, the current paper reviewed and analysed food balance sheets, peer-reviewed articles, and reports on food security to describe the current situation and changes pertaining to Ghana's food production, trade, safety, and consumption, to inform the development of food-based dietary guidelines (FBDG) for the country.

MATERIALS AND METHODS

Data collection and analysis

This mixed methods review study included data from 1) published peer-reviewed articles of studies on food security conducted at the household level from 2010 to 2020, 2) institutional reports from local and international organizations on food supply, 3) Food and Agriculture Organization (FAO) Corporate Statistical Database (FAOSTAT) for the period 2010 - 2018, 4) FishStatJ software v.4.00.16 for the period 2010 – 2018, and 5) the World Bank World Development Indicators for the period 2010 - 2018.



A search strategy (Table 1) was developed following the Population, Exposure, Outcome (PEO) framework suitable for qualitative reviews [7] and was applied to PubMed and Scopus. Subsequently, a search was conducted in Google Scholar for additional articles. Additionally, relevant institutional reports were obtained from members of the multi-sectoral Technical Task Team for the development of the food-based dietary guidelines. Only papers written in the English language and studies carried out in Ghana were included in the search. The papers were downloaded and uploaded into the Rayyan Qatar Computing Research Institute (QCRI) web application to remove duplicates. Screening of the titles and abstracts was performed on the Rayyan QCRI web application. Subsequently, relevant content was extracted using an extraction tool. The findings were qualitatively synthesized [7, 8], describing the changes observed in food production, consumption and food safety-related public health issues in Ghana over the 10-year period.

Food production, consumption, and trade data from the FAO data sources were grouped into food groups and their corresponding food items (Table 2). Data from FAOSTAT, FishStatJ software v.4.00.16, and population data from the World Bank World Development Indicators were used to compute the means, per capita production and consumption, and Compound Annual Growth Rates (CAGR) to show changes in production, consumption, and trade. The CAGR formula used in this study was adopted from Rani *et al.* [9].

RESULTS

Patterns in food production and consumption at the national level

Trends in food production and consumption from 2010 to 2018, at first glance, shows that per capita food production is higher than per capita food consumption in all the food categories, except for vegetables, and fish and fishery products (Figures 1-3). Average production was highest in the roots and tubers category, with vegetable fats and oils being the least average production category (Table 3). By quantity, cassava was the top-produced crop in the root crops and plantains category, with an annual production average of 16.7 million tonnes, growing at a rate of 5.6% per year. 1) Maize, 2) cowpeas, 3) oil palm fruit, 4) palm oil, 5) oranges, 6) tomatoes, 7) green chillies, and 8) meat (from slaughtered foreign breeds in-country) were the top produced food items in the 1) grains, cereals and cereal products, 2) beans and pulses, 3) oil-bearing crops and nuts, 4) vegetable fats and oils, 5) fruits, 6) vegetables, 7) spices, and 8) livestock product categories, respectively (Table 3).

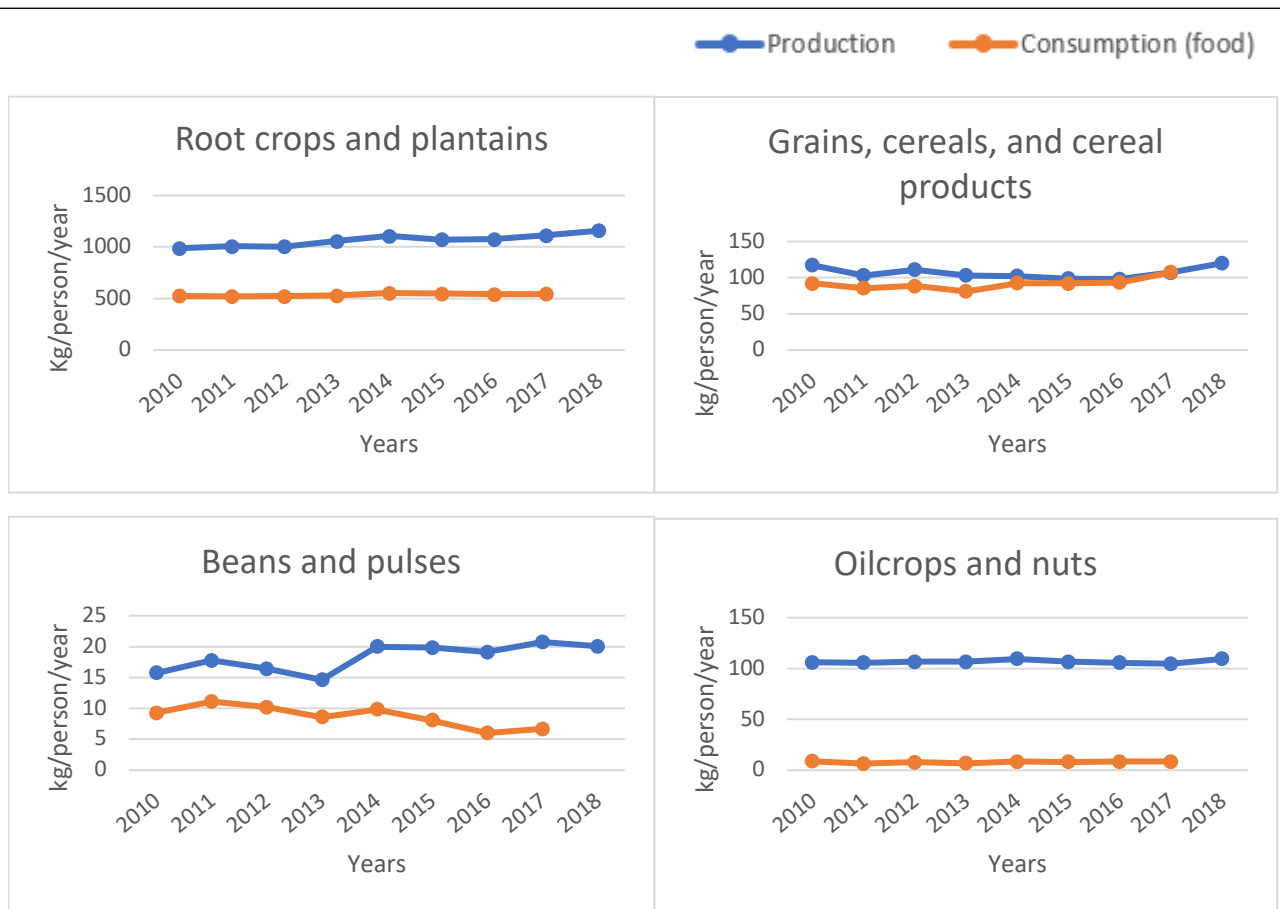


Figure 1: Trends in food production and consumption in Ghana from 2010 – 2018

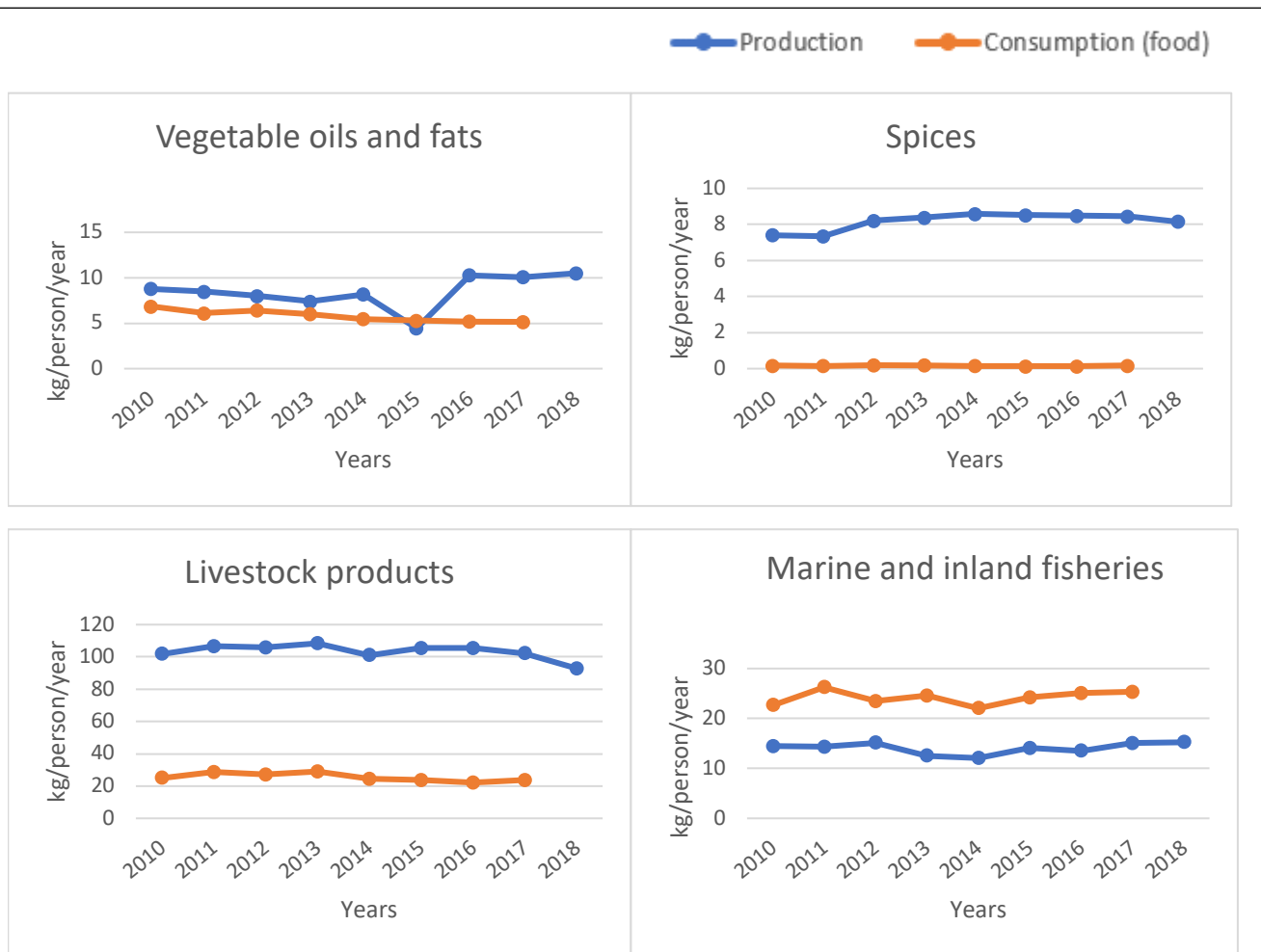


Figure 2: Trends in food production and consumption in Ghana from 2010 – 2018

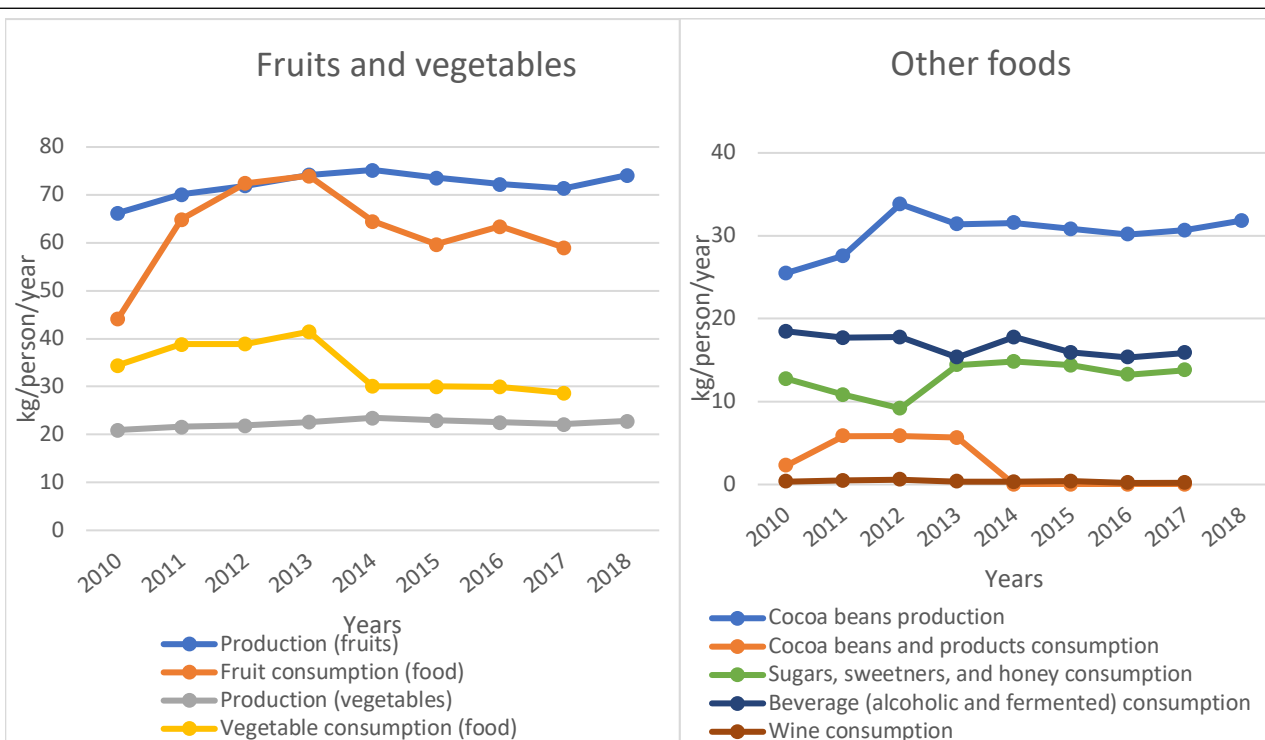


Figure 3: Trends in food production and consumption in Ghana from 2010 – 2018

Root crops and plantains category recorded the highest average consumption in tonnes in both the food and feed categories (Table 4). 1) Cassava, 2) rice and products (Table 2), and 3) beans were the top food items available for consumption in the 1) root crops and plantains, 2) grains, cereals, and cereal products, and 3) beans and pulses categories. For 1) oil-bearing crops and nuts and 2) vegetable fats and oils categories, groundnuts and palm oil were the top food items available for consumption. 1) Oranges, 2) tomatoes, and 3) pepper were the top food items available for consumption in the 1) fruits, 2) vegetables, and 3) spices categories. Milk was the top food item available for the livestock product category (Table 4). Marine and inland fisheries recorded a high average annual consumption of 652,000 tonnes compared to an average annual production of 383,000 tonnes. The average annual consumption of alcoholic and non-alcoholic beverages recorded the highest of 450,000 tonnes, followed by sugars, sweeteners, and honey (350,000 tonnes) in the other food category.

Patterns in food imports and exports at the national level

Generally, food imports exceeded food exports in the 1) grains, cereals and cereal products, 2) beans and pulses, 3) vegetables, 4) spices, 4) livestock products, 5) fish and fishery products, 6) sugars, sweeteners and honey, and 7) non-alcoholic beverages categories (Figures 4 - 6). Root crops and plantains category recorded two sharp declines in exports in 2013 and 2016 (Figure 5). The fruits category recorded fluctuations in both imports and exports. However, imports of fruits exceeded exports between 2014 and 2018 (Figure 5).

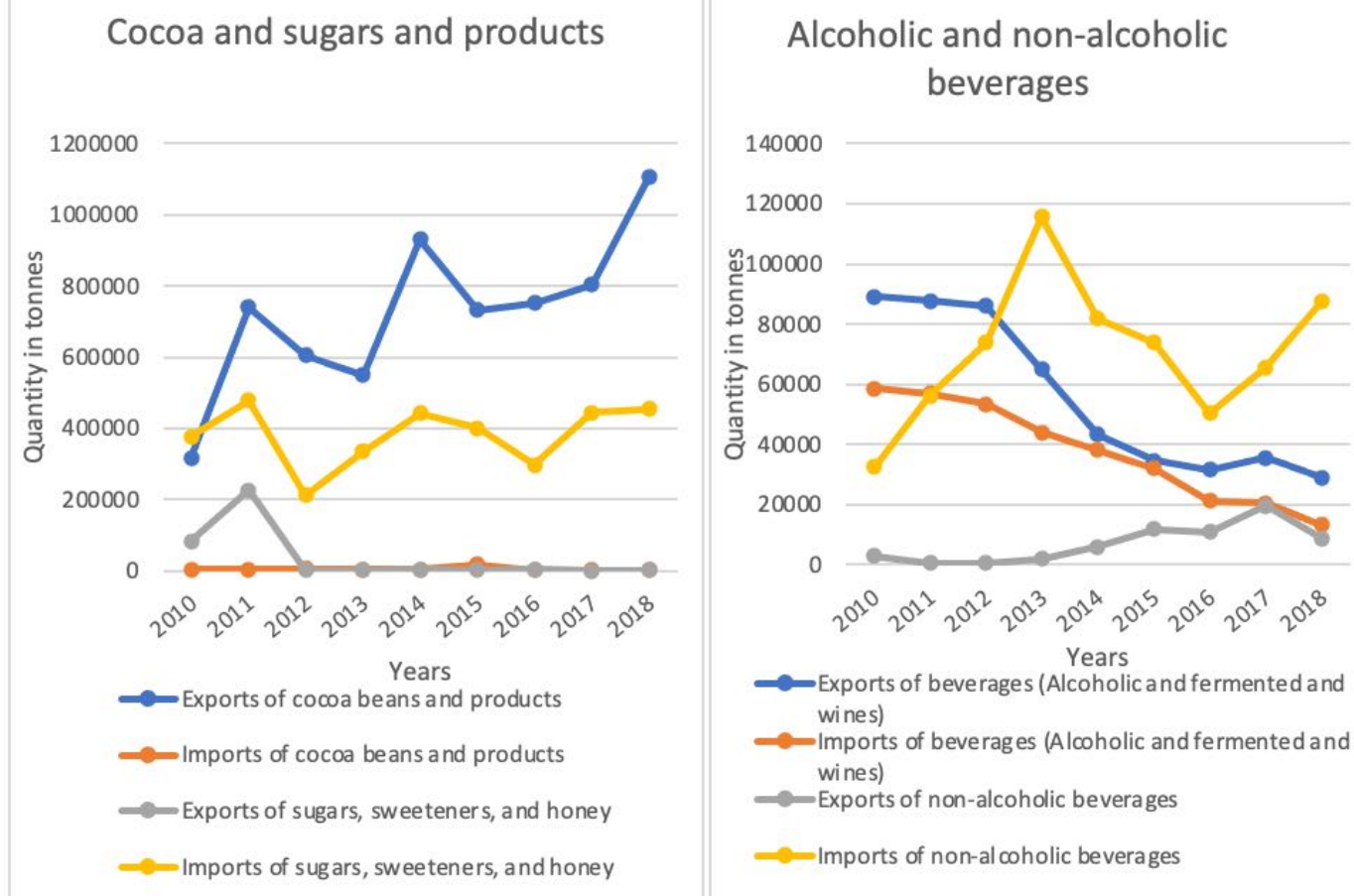


Figure 4: Trends in food exports and imports in Ghana from 2010 – 2018

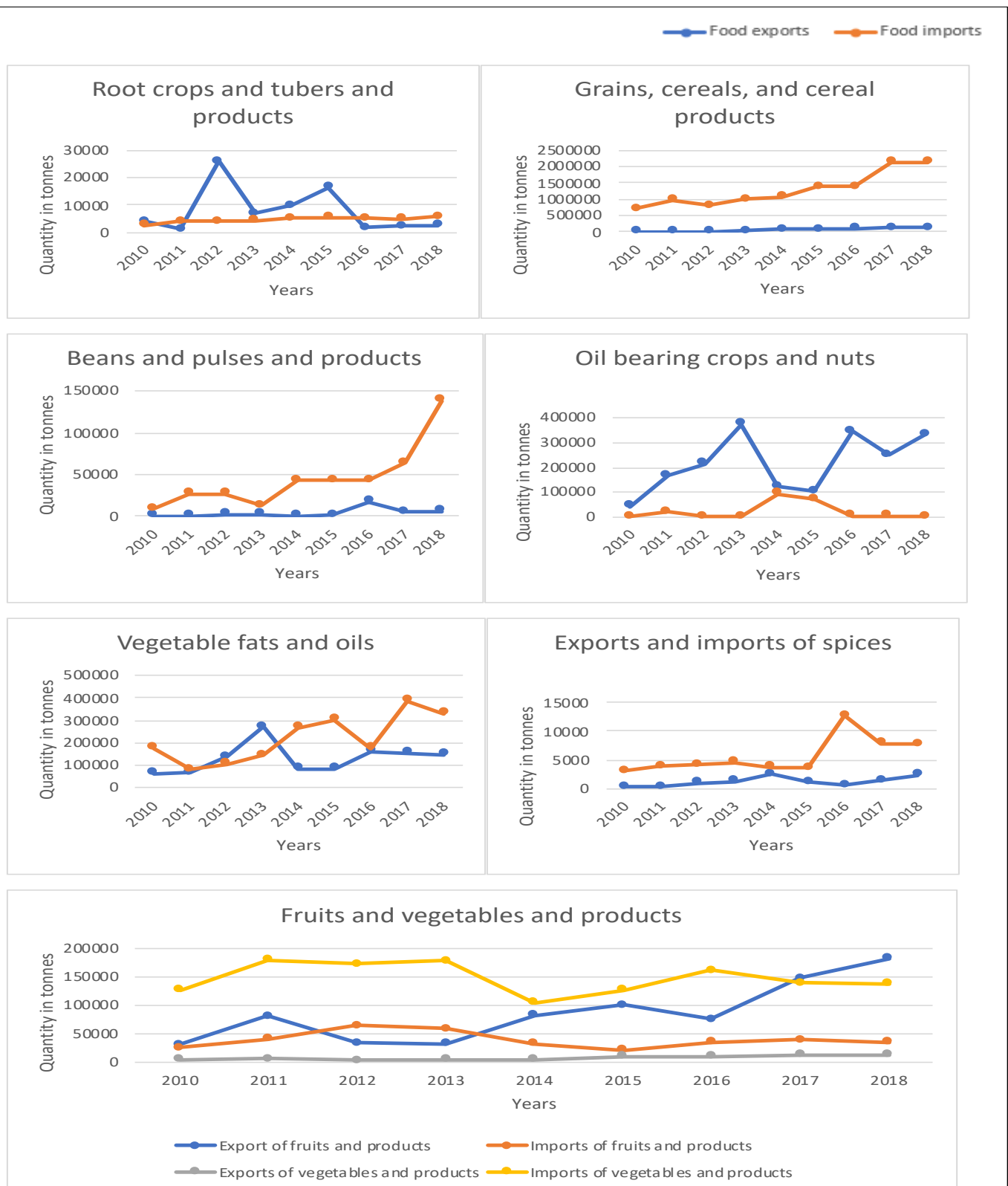
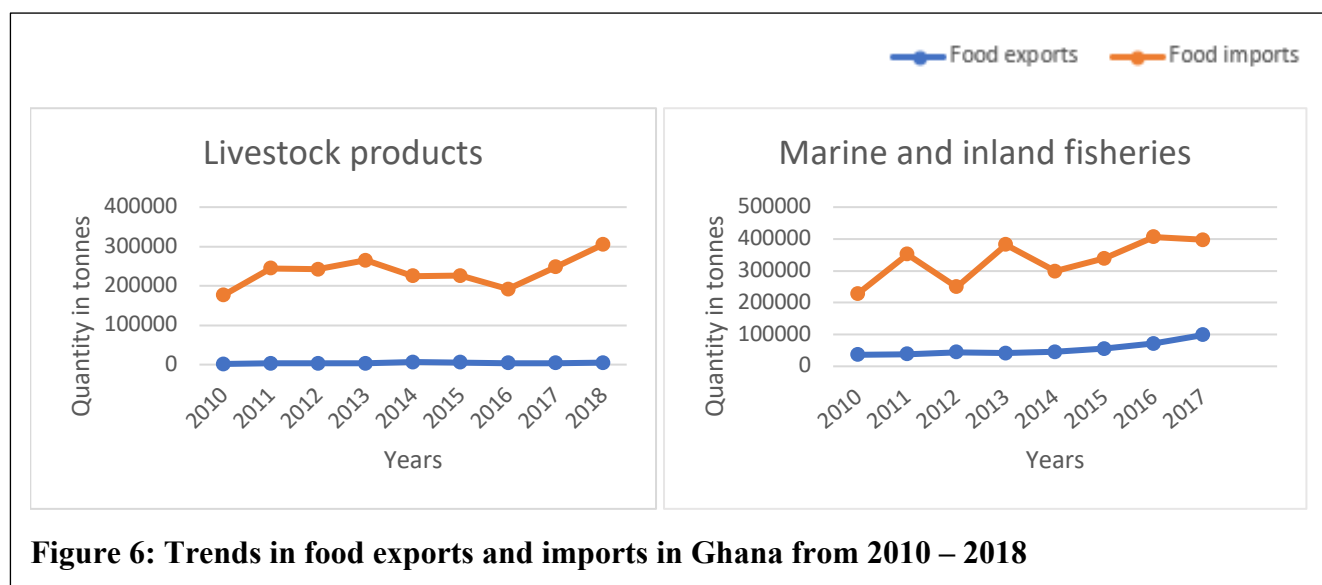


Figure 5: Trends in food exports and imports in Ghana from 2010 – 2018



Other roots and tubers (Table 2) was the top exported food item while potatoes were the top imported food item in the root crops and plantains category. For the grains, cereals, and cereal products category, the top exported food item was wheat flour, while the top imported food item was wheat. Soybeans and products were the top imported and exported food items in the beans and pulses category. The top exported and imported food item was palm oil in the vegetable fats and oils category. Canned tomato paste was the top exported and imported food item in the vegetables category. For livestock products, chicken meat was the top exported and imported food item (Table 5). The average annual imports of fish were six times higher (approx. 331,000 tonnes) than average annual exports (approx. 54,000 tonnes) (Table 5). Imports of sugars, sweeteners, and honey were ten times higher than exports (Table 5). Similarly, non-alcoholic beverages recorded higher imports (70,800 tonnes) than exports (15,000 tonnes).

Household food production and household diets

The Ghana Living Standard Survey (GLSS) 7 report and three selected studies were the key sources of information to understand how household food production contributes to households' diets in Ghana's southern and northern sectors [10 -13].

The value of a household's own-production used for food was GH¢3,363.87¹[13]. Roots, tubers, and plantain constituted 64.5% of the annual consumption value, with grains, flours and vegetables accounting for approximately 20% and 6.8%, respectively [13]. Households in Northern Ghana consumed more of their farm produce than sold, with an estimated value for consumption of own-production at 55% [10]. However, other studies from rural Northern and Southern Ghana reported that the average smallholder farming household was only marginally covered by their own food

¹ Value computed from farm-gate prices.

production to meet their food and nutrition needs, with more than half of households not meeting their meat, milk, vegetables, and fruits requirements [11,12].

Availability and consumption of underutilised foods (wild and produced)

Neglected and underutilised species (NUS) refers to those food crops and edible plant and animal species to which little attention is paid or are entirely ignored by agricultural researchers, plant breeders and policymakers [14]. A number of underutilised plant species were identified (Table 6). Palm weevil larvae (*akokono*) and turkey berries (*Kwahu nsusua*) were found to be nutritious but underutilised in Ghana [15]. Some non-timber forest products such as snails, mushrooms, antelopes, and grass-cutters, were reported to have received less policy and program attention, although they have a high potential of contributing to the food security and nutrition agenda in the country [16]. Additionally, indigenous vegetables such as cocoyam leaves, *ayoyo* and *gboma* were mostly underutilised, compared with some commonly used exotic vegetables in Ghana such as cabbage and lettuce [17]. Consumption of underutilised foods mostly occurred during the lean seasons (June, July, August). However, domestication of some non-timber forest products such as grass-cutters, snails, and mushrooms promoted these commodities' availability all year round [15, 16, 18].

Seasonality of food crops and household food availability

Four articles and the GLSS 7 report were the key sources of information on food crops' seasonality and household food availability. The seasonal patterns of harvesting, selling, and consuming staple crops such as cassava, yam, cocoyam, plantain, maize, rice, sorghum, and millet in Ghana were reviewed. Variations exist in the pattern of harvesting cereals. For instance, maize was often harvested from July to October, whereas October to December marked the harvesting season for rice and millet [13].

Demand often exceeded the supply of locally grown cereals in the early part of the year, from February through to June, due to little or no harvesting of such crops. Similarly, variations were reported in the harvesting and sale of roots and tubers, although such crops are more available from the middle to the latter part of the year [19]. Moreover, handling during harvesting contributed to two-thirds of post-harvest fruit loss, especially during harvest seasons. Commonly consumed fruits such as banana and pineapple were reported to be readily available all year round, whereas fruits such as mango, avocado, guava, and orange were out of season in April, May, October, November and December [19].

Seasonality also influenced availability and diversity in the consumption of vegetables, Vitamin A-rich fruits, and other staples. A study in Northern Ghana reported that consumption of Vitamin A-rich fruits and Vitamin A-rich dark green leafy vegetables were 64.0% and 52.6%, respectively [12]. Moreover, Vitamin A-rich deep-yellow, red, and orange vegetables were eaten more during the dry season (73.7%) than in the rainy season (36.4%) [20].

Armar-Klemesu *et al.* [12] highlighted some food adjustments during lean seasons in the southern and northern parts of Ghana. First, changes were made in food preparation and consumption [12]. For instance, bra leaves, kontomire, and fufu (fresh cassava and

plantain) become scarce in the lean season. Thus, the aforementioned foods were substituted with wild bra leaves, dandelion, and konkonte in the lean season, respectively. Secondly, changes were made to the fundamental structure of typical meals. Maize flour, in some cases, was utilised for thickening soup dishes or consumed as a single-pot meal. Other staples were consumed without the usual stews and soups. In extreme cases, the frequency and portion sizes of meals were reduced [12].

Food safety-related public health issues in Ghana

Food safety has been defined as "protecting the food supply from microbial, chemical and physical hazards that may occur during all stages of food production, including growing, harvesting, processing, transporting, retailing, distributing, preparing, storing, and consumption" [21]. Ten peer-reviewed articles and two policy documents on food safety were reviewed. Key food safety health issues included microbial contamination, aflatoxin contamination, polycyclic aromatic hydrocarbons in smoked fish, mercury in fish, pesticide residues in vegetables and fruits, and food adulteration.

Microbial contamination

A meta-analysis conducted by Saba and Gonzalez-Zorn [22] on food safety in Ghana reported *Enterobacter spp.* (65%), *Citrobacter spp.* (50%), *Klebsiella spp.* (46%), and *Escherichia spp.* (38%) as the most predominant bacteria species in Ghanaian foods. Macaroni, salad, and milk recorded the highest bacterial contamination (Table 7).

Aflatoxin contamination

Aflatoxins were highly prevalent among staple crops, including maize, groundnuts, sorghum, millet, and animal products such as meat, fish, eggs, and processed foods [23]. Agbetiamah *et al.* [24] reported that more than 15% of maize and 11% of groundnut exceeded the acceptable limits for aflatoxin contamination set by the Ghana Standards Authority (that is <15 parts per billion (ppb) for maize and <20 ppb for groundnut).

Polycyclic aromatic hydrocarbons (PAH) in smoked fish

Palm *et al.* [25] identified 20 PAH in smoked fish samples collected from open markets in the Greater Accra and Central regions of Ghana. Out of the 20 PAH detected, Benzo(a)pyrene, which is suspected to be a carcinogen, was seen in most fish samples collected. Essumang *et al.* [26] reported similar findings for smoke-cured fish sampled from 12 fishing communities along Ghana's coastal belt. The sampled fish contained high levels of PAH, and the highest mean level of PAH contamination in fish recorded for Benzo(a)pyrene (73.78 µg/kg) [27].

Mercury in fish and other organisms

A study by Gbogbo *et al.* [27] reported that the mercury content for most organisms was found to be greater than the acceptable limit (that is >0.5 mg kg⁻¹). The sampled organisms from the Ankobra basin had the highest contamination (2.5 ± 2.59 µg g⁻¹), followed by the Densu basin (1.75 ± 1.35 µg g⁻¹) and then the Lower Volta river basin (0.74 ± 1.46 µg g⁻¹) [27].

Pesticide and heavy metal residues in vegetables and fruits

Two articles showing the trends in pesticide and heavy metal residue contamination in fruits and vegetables in Ghana were included in the review [28, 29]. Bempah *et al.* [28] found that organochlorines (such as Lindane) were the most predominant pesticide residue in fruits (41.4%) and vegetables (58.9%) found in urban and rural markets in Ghana. Another study reported that arsenic, lead, and mercury concentrations in vegetables grown at mining sites in the Obuasi Municipality exceeded their allowable limit. The carcinogenic risk associated with consuming vegetables contaminated with arsenic was 3.3×10^{-3} , higher than the acceptable risk level of 1×10^{-4} [29].

Food adulteration

Evidence on food adulteration was only available for palm oil. A study conducted in the Greater Accra region found that almost all (96%) of the palm oil samples (n=55) analysed for Sudan IV dye were not approved by Ghana's Food and Drugs Authority (FDA). Moreover, 60% of palm oil samples with FDA approval tested positive for Sudan IV dye [30].

DISCUSSION

Implications for food security and nutrition

The results observed above in the trend data analysis and the literature review have implications for Ghana's food and nutrition security. Food importation is an important component of Ghana's food supply. The key imported food commodities between 2010 and 2018 were rice, wheat, fish, chicken meat, sugars, and palm oil. Moreover, the bulk of food production and consumption in Ghana from 2010 to 2018 has been centred on the root crops and tubers category, with cassava recording the highest average production (Table 3). It is not surprising that cassava is an essential starchy staple crop in many Ghanaian households' diets, with gari being the most consumed cassava product [31]. Despite the steady increases in cassava production and consumption, there are concerns about its nutritional benefits, especially for children. A Study in Nigeria and Kenya reported micronutrient deficiencies of iron, zinc, and vitamin A in areas where children (aged two to five years) consumed cassava as a primary carbohydrate source [32]. Therefore, it is imperative for policymakers to implement interventions, such as food fortification programs, to improve the nutrient density of existing roots and tubers resources for better nutrition outcomes.

Maize, rice and wheat were the most available food items in the grains, cereals, and cereal products category. Trade data for rice and wheat between 2010 and 2018 suggested an increasing demand for rice and wheat. Regular consumption of whole grains contributes to preventing chronic diseases [33]. Considering the rise in chronic non-communicable diseases in Ghana [34] and the central role of cereals in Ghanaian diets, encouraging the consumption of wholegrain cereals and grains will be a viable intervention for agriculture and public health.

Beans, pulses, nuts, fish, and livestock products are important protein sources in Ghanaian diets. The results showed that fish consumption exceeded production between 2010 and 2018, implying an increase in demand. Similarly, the gap between

the production of livestock products and consumption has remained wide since 2010. From a health perspective, interventions are needed to narrow this gap while promoting increased consumption of fish and legumes and less red meat consumption.

Fruit and vegetable consumption in Ghana has been declining since 2013. The low intake of fruits and vegetables is among the top ten list of risk factors for mortality. Globally, 5.2 million deaths are attributed to the low consumption of fruits and vegetables, according to a Global Burden of Disease study in 2013 [35].

Sugars, sweeteners, alcoholic beverages, and sugar-sweetened beverages consumption have been rising since 2010. This finding is in line with a recent FAO report in 2017 that noted increases in the consumption of highly processed foods, including sugar-sweetened beverages [36]. Low fruit and vegetable consumption, coupled with increases in the consumption of highly processed foods, mirror the nutrition transition in Ghana. A study in 2019 among urban households in Ghana showed that consumption of unhealthy foods was widespread, with 94% of participating households in Accra and Ho consuming energy-dense foods [37]. Therefore, it is crucial to develop FBDG for the Ghanaian population to educate people on making healthy food choices.

Household food production, seasonality, consumption, and implications

The findings showed that households' own production is more likely to be consumed by the household than sold for income. Although most households engage in crop and animal rearing diversification, the quantity of their own food produced is inadequate to meet households' dietary needs. Reliance on food purchases is critical to meeting dietary needs, even for households that produce food. Similar findings have been reported in other developing countries where dietary diversity was below the requirement, and the norm was dependence on market food sources [38]. Therefore, it is important to enhance both households' production and purchasing power in order to meet their food requirements.

Biodiversity is essential for food security, diet quality and nutrition at the household level [39]. Many people, especially rural populations, rely on wild foods as a source of protein and other important micronutrients and safety nets in the lean seasons. Over twenty (20) readily available but underutilised foods were identified in Ghana. Most of the foods identified were either from wild or grown crops and animal sources. Moreover, underutilized foods are less costly and have known nutritional value, which can substitute milk, meat, and other expensive proteins [14,40]. Considering the potential contribution of biodiversity to nutrition, there is a need for the relevant sector ministries such as the Ministry of Food and Agriculture, Ministry of Health and the Ministry of Lands and Natural Resources to enact a national policy on underutilised food to create awareness of its relevance to food security in Ghana.

The findings further indicate that, like other low-and-middle-income countries, Ghanaian households were likely to be food insecure during the dry season [41]. Demand was higher than supply for cereals, roots and tubers (the widely consumed food crops in Ghana) during the early months of the year. The findings showed that post-harvest losses of fruits and vegetables may threaten Ghana's food and nutrition

security. Food storage and processing systems are essential to reduce post-harvest losses and ensure year-round food availability. Current government interventions such as the One-District-One-Factory could serve as a basis to facilitate the addition of value to farm produce and contribute to reductions in post-harvest losses. [42].

Food safety issues in Ghana and implications

Food safety is a significant public health challenge in Ghana. There is poor compliance to food safety regulations leading to several food items on the Ghanaian market having contaminants exceeding the acceptable limits [21]. There is a need to advance monitoring through collaborative efforts by the Ministry of Health, the Food and Drugs Authority, the Ministry of Food and Agriculture, the Ghana Standards Authority and other local authorities. Moreover, underutilised foods have received less policy and program attention, although they have the potential to contribute to food security and nutrition at the household level.

Strengths and limitations

The use of the CAGR in this study is one of the most accurate ways to determine trends over time and has been used extensively in agriculture economics. The FAOSTAT and FishStat data is based on nationally representative datasets and does not provide information on food production, consumption, and food trade among Ghanaian communities and households. The FAO data used in this study had significant gaps in terms of missing data; thus, 'n/a' was used to represent food items with missing data in the tables. Moreover, the authors sought clarifications from resource people in Ghana's Ministry of Food and Agriculture who have experience with the crops or food items in question. The authors used their discretion to decide on the food items and categories used in this study and acknowledge that this may complicate comparisons with other studies.

CONCLUSION

The interplay between food production, consumption, trade, and food safety is important for Ghana's food security and nutrition. This study's main objective was to review existing evidence on the current situation and trends related to food production, trade, safety, and consumption in Ghana as part of a process to develop FBDG for Ghana. The analysis showed that root crops and tubers were the most important for food production and consumption. Consumption of fruits and vegetables has been declining since 2013, while the imports of highly processed foods are rising. There is an increasing demand for imported food, especially rice and wheat.

Therefore, domestic resources for wheat, rice, and underutilised foods production should be fully explored and utilised. There is a need to enhance multi-sectoral monitoring and evaluation of food value chain activities and interventions to 1) ensure adherence to food safety measures and 2) increase nutrient-dense and underutilised foods production. Policy attention directed at enhancing multi-sectoral strategies will be instrumental to developing and implementing Ghana's FBDG to educate the population on making healthy food choices.

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Table 1: Search terms used in Scopus and PubMed databases

Database	Search terms	Date of search
PubMed	1. <i>(Food product* OR Food availab*) AND Ghana</i>	September 18, 2020
Scopus	2. <i>(Food trade OR export* OR import*) AND Ghana</i>	September 18, 2020
	3. <i>(Household food available* OR Household food product*) AND household diet* AND Ghana</i>	
	4. <i>Seasonality AND (Household food available* OR Household food product*) AND Ghana</i>	
	5. <i>Underutilised food* AND Ghana</i>	
	6. <i>Food safety AND Public Health AND Ghana</i>	

Table 2: Food categories and associated foods used in the analysis

Categories	Production	Export/import	Available for food and feed
Root crops, tubers and plantain	Cassava, yam, plantain, cocoyam, sweet potatoes, other roots and tubers ²	Dried cassava, cassava flour, cassava starch, potatoes, potatoes flour, frozen potatoes, sweet potatoes, other roots and tubers, other roots and tubers flour, plantains	Cassava and products, yam, plantains, sweet potatoes, potatoes and products, other root crops
Grains, cereals, and cereal products	Maize, paddy rice, sorghum, millet, and oats	Maize, Maize bran, maize flour, maize (green), rice (broken, husked, milled, paddy), rice flour, wheat, wheat flour, wheat bran, buckwheat, millet, barley, beer of barley, cereals ³ (breakfast ⁴ and flour ⁵), mixed grain ⁶ (flour), sorghum, malt and malt flour, oats, rolled oats, and sweet corn (frozen/prepared), malt, and	Barley and products, maize and products, sorghum and products, wheat and products, millet and products, oats, rice and products ⁷ , and other cereals.

² Other roots and tubers are crops that have minor national and international relevance. These include arracacha (*Arracacia xanthorrhiza*); arrowroot (*Maranta arundinacea*); chufa (*Cyperus esculentus*); sago palm (*Metroxylon spp.*); oca and ullucu (*Oxalis tuberosa* and *Ullucus tuberosus*); yam bean, jicama (*Pachyrhizus erosus*, *P. angulatus*); mashua (*Tropaeolum tuberosum*); Jerusalem artichoke, and topinambur (*Helianthus tuberosus*)

³ Cereals are crops that have minor national and international relevance. These include canagua or coaihua (*Chenopodium pallidicaule*); quihuicha or Inca wheat (*Amaranthus caudatus*); adlay or Job's tears (*Coix lacryma-jobi*); and wild rice (*Zizania aquatica*)

⁴ Breakfast cereals include foods prepared by swelling and roasting cereals or cereal products, e.g., corn flakes, puffed rice; cereals o/t maize, in grain form, precooked or otherwise prepared

⁵ Cereals flour is broadly defined to include meal, groats, and pellets

⁶ Mixed grain is a mixture of cereal species that are sown and harvested together. For example, the mixture wheat/rye is known as meslin, but in trade is usually classified with wheat

⁷ Rice and products include paddy rice, husked rice, milled rice, broken rice, gluten rice, rice starch, rice bran, and rice flour

		sweet corn (preserved and frozen)	
Beans and pulses	Cowpeas (dry), soybeans, beans (dry and green), pulses.	Bambara beans, soybeans, beans ⁸ (dry and green), Soybeans, soybean (cake), broad beans, pulses ⁹ (flour), and lentils	Beans, pulses and products, and soybeans
Oil bearing crops and nuts	Oil palm fruit, groundnuts (with shell), cashew nuts (with shell), shea nuts, kola nuts, other nuts ¹⁰ , and oilseeds ¹¹ .	Almond (shelled and unshelled), Cashew nuts (shelled and unshelled), linseed cake, rapeseed cake, sunflower cake, shea nuts, chestnut, linseed, groundnuts (prepared and shelled), groundnut cake, palm kernel cake, kola nuts, oilseeds and products, other nuts and products, peanut butter, poppy seed, rapeseed, sesame seed, sunflower seed, walnuts (shelled and unshelled).	Groundnuts (shelled), other oil crops and products, rape and mustard seed and products, other nuts and products.

⁸ Beans includes kidney, haricot bean, lima, butter bean, adzuki bean, mungo bean, golden, green gram, black gram, urd scarlet runner bean, rice bean, moth bean, and tepary bean

⁹ Pulses includes lablab or hyacinth bean (*Dolichos spp.*); jack or sword bean (*Canavalia spp.*); winged bean (*Psophocarpus tetragonolobus*); guar bean (*Cyamopsis tetragonoloba*); velvet bean (*Stizolobium spp.*); yam bean (*Pachyrrhizus erosus*)

¹⁰ Other nuts include pecan nut (*Carya illinoensis*); butter or swarri nut (*Caryocar nuciferum*); pili nut, Java almond, Chinese olives (*Canarium spp.*); paradise or sapucaia nut (*Lecythis zabucajo*); Queensland, macadamia nut (*Macadamia ternifolia*); pignolia nut (*Pinus pinea*), chestnut, hazelnut, walnuts products, peanut butter

¹¹ Oilseed includes beech nut (*Fagus sylvatica*); (*Aleurites moluccana*); (*Carapa guineensis*); (*Croton tiglium*); (*Bassia latifolia*); (*Guizotia abyssinica*); (*Licania rigida*); (*Perilla frutescens*); (*Jatropha curcas*); (*Shorea robusta*); (*Pongamia glabra*); (*Astrocaryum spp.*); Linseed; Rapeseed; Sesame seed; Sunflower seed; Poppy seed; Almond seed. Products of oil seed include linseed cake, rapeseed cake, and sunflower cake

Vegetable fats and oils	Palm oil, groundnut oil, palm kernel oil, coconut oil	Palm oil, palm kernel oil, vegetable oil ¹² , rapeseed oil, coconut oil, groundnut oil, soybean oil, sunflower oil, and other oils ¹³ .	Coconut oil, groundnut oil, olive oil, palm oil, palm kernel oil, soyabean oil, and sunflower seed oil.
Fruits and vegetables	Tomatoes, onions, okra, eggplants, cucumbers, other vegetables ¹⁴ , oranges, pineapples, coconuts, mangoes, mangosteens, guavas, banana, lemons and limes, avocados, papayas, and other fruits ¹⁵	Cabbages and other brassicas, carrots and turnips, cauliflower and broccoli, chick peas, cucumbers and gherkins, artichokes, asparagus, eggplants, leeks, other vegetables, lettuce and chicory, olives, preserved olives, onions (dry), onions (shallots), peas (dry and green), pumpkins, squash, and gourds, sugar beet, tomatoes, spinach, apples, apricots (dry), blueberries, cherries, coconuts, cranberries, currents, dates, grapefruit,	Apples and products, bananas, citrus (other), coconuts, dates, fruits (other), grapefruit and products, grapes and products, lemons, limes and products, orange and mandarins, pineapples and products, onions, peas, tomatoes, and other vegetables.

¹² Vegetable oil includes myrtle wax and Japan wax

¹³ Other oils include boiled, linseed, maize, olive, safflower, and sesame

¹⁴ Other vegetables include bamboo shoots (*Bambusa spp.*); beets, chards (*Beta vulgaris*); capers (*Capparis spinosa*); cardoons (*Cynara cardunculus*); celery (*Apium graveolens*); chervil (*Anthriscus cerefolium*); cress (*Lepidium sativum*); fennel (*Foeniculum vulgare*); horseradish (*Cochlearia armoracia*); marjoram, sweet (*Majorana hortensis*); oyster plant (*Tragopogon porrifolius*); parsley (*Petroselinum crispum*); parsnips (*Pastinaca sativa*); radish (*Raphanus sativus*); rhubarb (*Rheum spp.*); rutabagas, swedes (*Brassica napus*); savory (*Satureja hortensis*); scorzonera (*Scorzonera hispanica*); sorrel (*Rumex acetosa*); soybean sprouts tarragon (*Artemisia dracunculus*); watercress (*Nasturtium officinale*)

¹⁵ Other fruits include azarole (*Crataegus azarolus*); babaco (*Carica pentagona*); elderberry (*Sambucus nigra*); jujube (*Zizyphus jujuba*); litchi (*Nephelium litchi*); loquat (*Eriobotrya japonica*); medlar (*Mespilus germanica*); pawpaw (*Asimina triloba*); pomegranate (*Punica granatum*); prickly pear (*Opuntia ficus-indica*); rose hips (*Rosa spp.*); rowanberry (*Sorbus aucuparia*); service-apple (*Sorbus domestica*); tamarind (*Tamarindus indica*); tree-strawberry (*Arbutus unedo*)

grapes, kiwi fruit,
lemons and limes,
mangoes,
mangoesteen,
guavas, melons,
oranges, papayas,
peaches and
nectarines, pears,
pineapples,
strawberries,
watermelons,
bananas, raisins,
tangerines,
mandarins,
clementine,
satsumas, Coconuts
(desiccated), juice
(apple, citrus, other
fruits, grape,
grapefruit, lemon,
orange, pineapple,
tomato), pineapples
canned, plums and
sloes, plums dried
(prunes), tomatoes,
paste, tomatoes
(peeled, juice), other
vegetables (in
vinegar, dehydrated,
fresh, frozen,
prepared, preserved,
waxes) waxes
vegetable, other
fruits (dried, cooked,
prepared, fresh,
tropical), Mushrooms
and truffles (canned)

Spices	Ginger, Chillies and peppers ¹⁶ (green and dry), pepper ¹⁷	Chillies and peppers (dry and green), cinnamon, cloves, ginger, garlic, pepper, other spices	Pepper, other spices
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¹⁶ Chillies and pepper include red and cayenne pepper, paprika, chillies (*Capsicum frutescens*; *C. annum*); allspice, Jamaica pepper (*Pimenta officinalis*)

¹⁷ Pepper includes black pepper, white pepper, and long

		(anise, badian, fennel, coriander)	
Livestock products	Meat from foreign breeds (cattle, chicken, goat, pig, and sheep), game (meat), meat from local breeds (cattle, chicken, goat, pig, and sheep), milk (fresh), eggs, fats (goats, pigs, cattle, and sheep), offals (cattle, goats, pigs, sheep), and cattle hides (fresh).	Milk (natural, skimmed, whole), butter, buttermilk, cheese, cheese (sheep milk), yoghurt, whey (condensed and dried), meat meal, meat (chicken, beef, duck, goose, guinea fowl, turkey, veal sausages, cattle, dried, game, goat, horse, pig, pig sausages, pork, rabbit, sheep), fat (prepared, cattle, liver prepared, pigs), hides (cattle), bacon and ham, eggs, offals (cattle, chicken, liver duck, liver geese, pigs, and sheep), cream	Bovine meat, butter, cream, eggs, animal fats, other meats, milk, offals, mutton and goat meat, pig meat, and poultry meat
Fish and fishery products	All data on marine and inland fisheries	All data on marine and inland fisheries	All data on marine and inland fishery
Other foods			
Sugars, sweeteners, and honey	Sugar (raw, confectionery, and refined), honey, and other sweeteners		
Beverages (alcoholic and non-alcoholic)	Beer, alcoholic beverages, and fermented beverages, wines, non-alcoholic beverages		
Cocoa beans and products	Chocolate products, cocoa beans, cocoa butter, cocoa paste, cocoa powder and cake		

Table 3: Food production in Ghana from 2010 – 2018

Group	Food items	Production	
		Average quantity (1000 tonnes)	Compound annual growth rate (%)
Root crops and plantains	Cassava	16,772	5.6
	Yams	7,060	3.5
	Plantains	3,811	2.1
	Sweet potatoes	138	2.9
	Cocoyam	1,326	0.9
	Other roots and tubers	0.174	2.6
Grains, cereals, and cereal products	Maize	1,863	2.6
	Rice (paddy)	603	5.8
	Sorghum	272	-0.3
	Millet	173	-2.3
	Oats	0.044	4.1
Beans and pulses	Cowpeas (dry)	189	-1.2
	Soybeans	150	0.5
	Beans (dry)	168	-2.4
	Pulses	25	1.7
	Beans (green)	25	2.3
Oil bearing crops and nuts	Oil palm fruit	2,339	3.3
	Groundnuts (with shell)	456	-0.2
	Cashew nuts (with shell)	55	10.5
	Karite nuts	34	-1.3
	Kola nuts	24	2.8
	Other nuts	1.4	1.8
	Oilseeds	0.2	1.3
	Palm oil	181	12.7
Vegetable fats and oils	Groundnut oil	62*	-5.5*
	Palm kernel oil	20*	21.5*
	Coconut oil	9*	-2.1*
	Oranges	666	3.3
Fruits and vegetables	Pineapples	628	4.6

	Coconuts	363	3.8
	Mangoes, mangosteen and guava	96	4.3
	Bananas	83	n/a
	Lemons and limes	48	2.4
	Avocados	18	35.5
	Tomatoes	350	2.3
	Onions (dry)	136	5.9
	Okra	63	5.0
	Eggplants	48	3.6
Spices	Ginger	0.1	3
	Pepper spp.	3.7	2.7
	Chillies (dry)	106	3.1
	Chillies (green)	114	4
Livestock products	Meat (foreign breeds – cattle, chicken, game, goat, pig, sheep)	214	3.8
	Meat (local breeds – cattle, chicken, goat, pig, sheep)	51**	5.7**
	Milk	43	2.2
	Eggs	42	1.7
	Offals (cattle, goats, pigs, sheep)	15	3.6
	Fat (cattle, goats, pigs, sheep)	4	4.4
	Hides	3	3.2
Fish and fishery products	Marine and inland fisheries	383	3.0
Other foods	Cocoa beans	829	5.2

*Data was from 2010 – 2014. **Data was from 2010 – 2013

Table 4: Food consumption in Ghana from 2010 – 2017

Group	Food items		Food		Feed	
		Average per capita consumption (kg/person)	Average consumption in 1000 tonnes	Compound annual growth rate (%)	Average consumption in 1000 tonnes	Compound annual growth rate (%)
Root crops and plantains	Cassava	220	5944	3.7	4128	4.0
	Yams	151	4064	3.5	245	-11.9*
	Plantains	126	3389	2.0	No data	
	Sweet potatoes	4.9	131	1.2	4.3	-26.3*
	Other root crops	33.2	891	-2.0	40	-47.4*
Grains, cereals, and cereal products	Rice and products	35.9	972	5.9	16	48.7*
	Maize and products	25.9	695.9	0.8	825	0.2
	Wheat and products	18.2	494.5	12.4	No data	
	Sorghum and products	6.6	177.4	-4.5	10	-100*
	Millet and products	4.8	129.3	-3.5	No data	
	Oats	0.12	3.1	-100	0.71	-100
	Beans and pulses	Beans	8.0	212.8	-2.9	No data
	Pulses	0.1	20	2.9	1	0*
Oil bearing crops and nuts	Groundnuts (shelled)	5.9	158	2.2	No data	
	Other oil crops	0.2	5	7.2	8.6	-25
	Other nuts	0.9	24	-2.2	No data	
Vegetable fats and oils	Palm oil	2.6	69	-2.4	No data	
	Groundnut oil	2.3	62	-3.3		

	Coconut oil	0.3	9	0		
	Palm kernel oil	0.4	11	5.4		
Fruits and vegetables	Oranges	22	585	2.9		No data
	Pineapples	18	494	47.8		
	Coconuts	7	119	4.7	13.8	-28.3
	Bananas	1.8	47	6.2		No data
	Lemons and limes	1.7	45	1.7		
	Apples and products	0.78	20.5	-9.4		
	Tomatoes	19	507	-3.5		No data
	Onions	6.1	164	4.3		
Spices	Pepper	0.1	3	4.2		No data
Livestock products	Meat (bovine, goat, pig)	3.8	105	2.1		No data
	Poultry meat	7.2	194	5.1		
	Eggs	1.2	32	3.2		
	Milk	7.7	208	1.1	2.8*	0
	Offals	1.6	42.1	8.8	No data	
Fish and fishery products	Marine and inland fisheries	24.2	652	4	373	2.9
Other foods	Cocoa beans and products	2.5	63.4	-100		No data
	Sugars, sweeteners, and honey	13	350	3.5		
	Beverages (Alcoholic and fermented)	16.8	450	0.1		
	Wine	0.4	9.8	-5.6		

*Data was from 2014 – 2017

Table 5: Food trade in Ghana from 2010 – 2018

Group	Food items	Export		Import	
		Average quantity (1000 tonnes)	Compound annual growth rate (%)	Average quantity (1000 tonnes)	Compound annual growth rate (%)
Root crops and plantains	Other roots and tubers	4.2	n/a	0.004	n/a
	Other roots and tubers flour	1.7	-32.4	0.048	41.3
	Dried cassava	0.8	n/a	0.001	n/a
	Plantains	0.5	n/a	0.028	n/a
	Potatoes	0.1	n/a	1.928	0.1
	Frozen potatoes	0.004	n/a	2.038	17.0
	Sweet potatoes	0.1	n/a	0.024	n/a
Grains, cereals, and cereal products	Wheat flour	36.0	242.0	54	16.1
	Wheat bran	19.3	117.1	1.5	n/a
	Wheat	1.8	n/a	481.2	8.5
	Maize	2.9	-22.3	47.2	74.4
	Rice (broken)	0.2	n/a	430.4	8.9
	Rice (milled)	0.04	-2.3	173.6	20.5
	Rice (paddy)	0.03	n/a	0.876	110
Beans and pulses	Soybeans	3.2	171.8	2.5	83.3
	Beans (dry)	0.3	-12.7	13.8	-100
	Soybeans (cake)	0.2	n/a	29.9	n/a
	Beans (green)	0.03	30.7	0.2	-100
	Pulses (flour)	0.01	-100	0.04	18.9
Oil bearing crops and nuts	Groundnuts (shelled)	0.24	n/a	0.15	19.2
	Cashew nuts (with shell)	144.0	31.1	5	26.7
	Sesame seeds	18.4	18.8	1	-10.6
	Oilseeds	37.8	n/a	11	-15.3

Vegetable fats and oils	Palm oil	66.8	6.2	205.3	11.3
	Palm kernel oil	44.7	14.7	1.7	-7.4
	Vegetable oil	25.9	34.3	4.9	-56.4
	Groundnut oil	0.17	-4.8	0.03	38.4
	Coconut oil	0.41	-19.3	0.01	41.4
Fruits and vegetables	Oranges	6.6	0.4	0.1	33.3
	Pineapples	17.4	9.1	0.1	n/a
	Apples	0.1	n/a	7.9	6.4
	Coconuts	3.7	206.5	0.03	17.0
	Mangoes, mangosteen and guava	3.3	144.9	0.82	3.5
	Bananas	42.8	30.9	0.1	n/a
	Tomatoes	0.02	-100	7.8	8.4
	Onions (dry)	1	-47.3	63.1	4.0
	Orange juice (concentrate)	2	76.8	1	8.5
	Tomato paste	5.1	36.2	85.6	-2.0
Spices	Ginger	0.05	71	0.39	86.7
	Pepper spp.	0.23	10.5	1	42.3
	Chillies (dry)	0.01	n/a	0.01	33.4
	Chillies (green)	0.36	22.3	0.03	72.4
	Other spices	0.49	48.5	1.2	-3.8
Livestock products	Milk (Whole and dried)	0.4	102.9	3.1	-5.3
	Meat (chicken)	0.47	n/a	142.2	8.0
	Meat (cattle)	0.003	n/a	1.4	6.5
	Eggs (in shell)	0.14	42	0.02	5.7
	Offals (cattle)	0.12	n/a	23.7	14.3
Fish and fishery products	Marine and inland fisheries*	53.8	15.3	331.4	8.2
Other foods	Cocoa beans and products	726	16.9	4.4	-3.0

Sugars, sweeteners, and honey	35.2	-50.3	382.1	2.3
Beverages (Alcoholic and fermented and wines)	55.8	-13.1	37.6	-16.9
Beverages (non-alcoholic)	7	15.1	70.8	13.1

* Trade information for marine and inland fisheries was from 2010 to 2017.

Table 6: Underutilised plant species in Ghana

Category	Scientific name	Common name
Vegetables	<i>Tricizanthus cucumeria</i>	Snake gourd
	<i>Sechium edulis</i>	Chayote fruit
	<i>Telfaria occidentalis</i>	Fluted pumpkin
	<i>Cucumeropsis edulis</i>	Egusi
Indigenous leafy vegetables	<i>Cochorus olitorious</i>	Ayoyo
	<i>Solanum macrocarpum</i>	Gboma
	<i>Talinum triangulare</i>	Waterleaf
	<i>Amaranthus cruentus</i>	Amaranth grain
	<i>Basella alba</i>	Malabar spinach
Root and tuber crops	<i>Dioscorea cayenensis</i>	Yellow guinea yam
	<i>Dioscorea dumetorum</i>	Bitter yam
	<i>Dioscorea praehensilis</i>	Bush/white yam
Cereals and grains	<i>Digitaria exilis</i>	Fonio
	<i>Eleusine coracana</i>	Finger millet
	<i>Oryza glaberrima</i>	African red rice
	<i>Sorghum bicolor</i>	sorghum
	<i>Pennisetum americanum</i>	Pearl millet
Legumes	<i>Cajanus cajan</i>	Pigeon pea
	<i>Vigna subterranean</i>	Bambara bean
	<i>Mucuna pruriens</i>	Velvet bean
	<i>Canavalia ensiformis</i>	Jack bean
	<i>Canavalia gladiata</i>	Sword bean
	<i>Phaseolus lunatus</i>	Lima bean,
	<i>Dialium guineenses Willd</i>	Velvet tamarind,
	<i>Parkia biglobosa</i>	Locust bean (<i>Dawadawa</i>)

Table 7: Bacterial isolates present in Ghanaian foods

Food	Bacterial Isolates
Macaroni	<i>Shigella sonnei</i> , <i>Pseudomonas fluorescens/putida</i> , <i>K. pneumoniae</i> , <i>Enterobacter sakazakii</i> , <i>E. coli</i> (enteroaggregative diffuse), <i>Citrobacter freundii</i> , <i>Serratia liquefaciens</i> , <i>Enterobacter cloacae</i> , <i>Enterobacter agglomerans</i> , <i>E. coli</i> , <i>Citrobacter diversus/amaltonica</i> , <i>Citrobacter spp.</i> , <i>Proteus mirabilis</i> , <i>Proteus spp.</i> , <i>Enterobacter amnigenus</i> and <i>Pseudomonas cepacia</i>
Milk	<i>E. coli</i> , <i>Yersinia spp.</i> , <i>Klebsiella spp.</i> , <i>Proteus spp.</i> , <i>Enterobacter spp.</i> , <i>Staphylococcus spp.</i> , <i>Bacillus spp.</i> , and <i>Mycobacterium spp.</i>
Salad	<i>Pseudomonas aeruginosa</i> , <i>S. liquefaciens</i> , <i>E. sakazakii</i> , <i>E. cloacae</i> , <i>P. fluorescens/putida</i> , <i>C. freundii</i> , <i>E. coli</i> , and <i>C. diversus/amaltonica</i>
Fish	<i>C. diversus</i> , <i>E. coli</i> , <i>C. luteola</i> , <i>P. fluorescens/putida</i> , <i>E. sakazakii</i> , <i>C. diversus/amaltonica</i> , <i>K. pneumoniae</i>
Plantain	<i>Citrobacter spp.</i> , <i>K. pneumoniae</i> , <i>Acinetobacter spp.</i> , <i>Klebsiella spp.</i> , <i>Enterobacter spp.</i> , <i>C. freundii</i>
Red pepper	<i>K. pneumoniae</i> , <i>S. liquefaciens</i> , <i>Kluyvera spp.</i> , <i>E. cloacae</i> , <i>E. amnigenus</i> , <i>Citrobacter spp.</i>
Gari	<i>C. freundii</i> , <i>E. cloacae</i> , <i>C. luteola</i> , <i>Serratia funtida</i> , <i>E. aerogenes</i> , <i>E. agglomerans</i>
Waakye (rice and beans)	<i>Enterobacter spp.</i> , <i>Acinetobacter spp.</i> , <i>Erwinia spp.</i> , <i>E. cloacae</i> , <i>K. pneumoniae</i>
Rice	<i>E. coli</i> (enteroaggregative diffuse), <i>Serratia marcescens</i> , <i>K. pneumoniae</i> , <i>P. fluorescens/putida</i>
Chicken	<i>Shigella spp.</i> (imported chicken), <i>Salmonella spp.</i> , <i>Cambylobacter jejuni</i> , and <i>E. coli</i>
Yam	<i>C. freundii</i> , <i>K. pneumoniae</i> , <i>Citrobacter spp.</i> , <i>C. luteola</i>
Shito (over cooked stew)	<i>Klebsiella cloacae</i> , <i>K. pneumoniae</i> , <i>E. cloacae</i> , and <i>E. coli</i>
Tomato stew	<i>C. freundii</i> , <i>E. sakazakii</i> , <i>E. coli</i> (enteroaggregative localised)
Beans	<i>C. freundii</i> , <i>K. pneumoniae</i> , <i>E. cloacae</i>
Kenkey	<i>Pseudomonas spp.</i> , <i>Klebsiella spp.</i> , <i>Staphylococcus spp.</i>
Fufu	<i>C. diversus</i> , <i>E. cloacae</i> , <i>E. sakazakii</i>
Kebab (beef and pork)	<i>Escherichia coli</i> , and <i>Staphylococcus spp.</i>
Red oil	<i>Escherichia hermannii</i> , <i>C. freundii</i>
Koko	<i>Chryseomonas luteola</i> , <i>Shigella spp.</i>
Palm nut soup	<i>C. freundii</i> , <i>E. cloacae</i>
Akple/Banku	<i>E. cloacae</i> , <i>K. pneumoniae</i>
Nkontomire stew	<i>E. cloacae</i>
Groundnut soup	<i>C. freundii</i>
Light soup (meat)	<i>Salmonella arizonae</i>
Okro soup	<i>E. cloacae</i>
White oil	<i>Pseudomonas spp.</i>

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