

Article

# Role of Seaweed in Diets of Samoa and Kiribati: Exploring Key Motivators for Consumption

Hayley Butcher<sup>1</sup>, Sarah Burkhart<sup>1,2</sup> , Nicholas Paul<sup>3</sup> , Ulusapeti Tiitii<sup>3,4</sup>,  
Karibanang Tamuera<sup>5</sup>, Taati Eria<sup>5</sup> and Libby Swanepoel<sup>1,2,\*</sup> 

<sup>1</sup> School of Health and Sport Sciences, University of the Sunshine Coast, Maroochydore 4557, QLD, Australia; hrb014@student.usc.edu.au (H.B.); sburkhar@usc.edu.au (S.B.)

<sup>2</sup> Australian Centre for Pacific Islands Research, University of the Sunshine Coast, Maroochydore 4557, QLD, Australia

<sup>3</sup> School of Science and Engineering, University of the Sunshine Coast, Maroochydore 4557, QLD, Australia; npaul@usc.edu.au (N.P.); Sapeti.Tiitii@maf.gov.ws (U.T.)

<sup>4</sup> Ministry of Agriculture and Fisheries, Apia WS1300, Samoa

<sup>5</sup> Ministry of Fisheries and Marine Resources Development, PO Box 64 Bairiki, Tarawa, Kiribati; karibanangt@mfmrd.gov.ki (K.T.); taatie@fisheries.gov.ki (T.E.)

\* Correspondence: lswanepo@usc.edu.au

Received: 30 July 2020; Accepted: 2 September 2020; Published: 8 September 2020



**Abstract:** Edible seaweeds have significant potential to contribute to sustainable diets that promote health of Pacific Islanders in ecologically, economically, and socially acceptable ways. No studies to date have investigated motivators for and the consumption of edible green seaweed from the genus *Caulerpa* (sea grapes) in Samoa and Kiribati. An observational, cross-sectional study utilized an interviewer-administered questionnaire to explore consumption behaviors and the role of sea grapes in the current diets of individuals in Samoa and Kiribati. Of the total 145 participants (n = 79, 54.5% Samoa; n = 66, 45.5% Kiribati), half (n = 76, 52%) reported consuming sea grapes. A significantly greater proportion of Samoans (n = 56, 70.9%) reported consumption than I-Kiribati participants (n = 20, 30.3%). A greater proportion of consumers were male (n = 47, 61.8%). Samoan consumers reported consumption of sea grapes with a higher diversity of foods and being related to traditional events or ceremonies. Motivators for consumption varied between countries, with Samoan consumers reporting strong agreement for taste and value for money, and identified sea grapes as nutritious food, as influences on consumption. Easy access was a motivator in Kiribati only. The findings of this study are underpinned by the degree of food security and differences in culture in Samoa and Kiribati. Future public health efforts to integrate traditional fresh food into local food systems will need to work within the existing social parameters in each respective country.

**Keywords:** sustainable diet; algae; *Caulerpa*; research for development; RDI; livelihood; Pacific; nutrition; NCDs

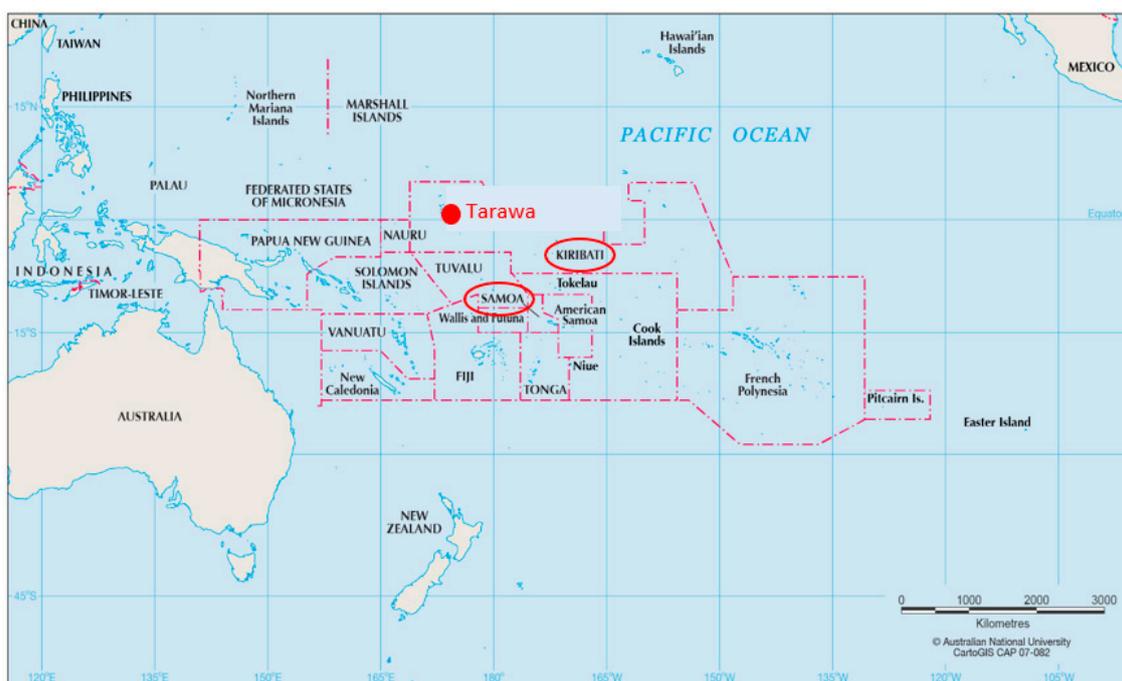
## 1. Introduction

The Pacific Islands are a collection of island nations located across the Pacific Ocean, which divide into the regions of Melanesia, Micronesia, and Polynesia [1]. Many Pacific populations are in nutrition transition, manifesting as changes in dietary intake and a move away from local food supply chains [2,3]. These nutrition transitions have coincided with a rise in the incidence of diet-related non-communicable diseases (DR-NCDs), such as cardiovascular disease, type 2 diabetes mellitus, and cancer [4], and these diseases are the leading cause of mortality in the Pacific region, accounting for 70–75 percent of deaths [5]. Poor diets are a major contributory factor to the rising prevalence of malnutrition in all its forms [6]. Following a sustainable healthy diet can promote optimal growth and development,

support functioning and physical, mental, and social wellbeing at all life stages for present and future generations, contribute to preventing all forms of malnutrition, reduce the risk of DR-NCDs, and support the preservation of biodiversity and planetary health [6]. Malnutrition is a key risk factor for NCDs, exhibiting as nutrient disorders caused by either deficient, excessive, or imbalanced intake of energy and nutrients [7]. Obesity, hyperglycemia and hypertension are diet-related risk factors linked to the manifestation of NCDs in the Pacific Islands [8].

Samoa and Kiribati are two countries located in the Pacific Islands region, close to the equator but separated by 1200 km [1] (Figure 1). Samoa, an independent country in Polynesia, is made up of two main islands, Upolu and Savai'i, and smaller islands as part of the archipelago, with a land area of 2841 km<sup>2</sup>. In 2018, Samoa had a population of 201,000 and a Gross Domestic Product (GDP) per capita of US\$ 6022 [9]. The Republic of Kiribati, located in Micronesia, is one of the most remote and geographically dispersed countries in the world, comprised of 32 atolls and one coral island with a land area of 811 km<sup>2</sup> [5]. In 2018, Kiribati had a population of 110,000, half of whom reside in the capital of South Tarawa, and a GDP per capita of US\$ 1981 [10]. In 2020, according to World Bank classifications, Samoa was ranked as an upper-middle-income country, whilst Kiribati was a lower-middle-income country [11]. While both are in the Pacific Ocean, Samoa and Kiribati have different food systems based on their geographical location, participation in trade, and land mass (volcanic soil in Samoa vs. coral atolls in Kiribati). A positive association between GDP per capita and intake across all food groups has been found, indicating poorer dietary diversity and diet quality in lower-middle-income countries [12]. Dietary shifts toward a modernized and less varied dietary pattern are considered a major factor in the rise of obesity and NCDs in Pacific Island countries, including in Samoa and Kiribati [13,14]. Samoa has higher dietary diversity in comparison to Kiribati, primarily due to greater access to a variety of foods (tubers, legumes, fresh fish and meat, fruit, and green leafy vegetables) [15]. Greater dietary diversity is typically indicative of better diet quality and improved health status [16]. The low dietary diversity in Kiribati has been linked to the high cost of imported foods, low socio-economic status, limited agricultural capacity secondary to environmental effects of climate change and geographic remoteness [17]. Each of these factors also increases the vulnerability of I-Kiribati people to food insecurity, defined as the situation that exists when people lack secure access to sufficient amounts and types of safe, nutritious food [13].

Edible green seaweeds (genus *Caulerpa*, commonly referred to as sea grapes) are a natural resource that grows on shallow reefs around Samoa and Kiribati. The term sea grapes includes several species of *Caulerpa*, two of which (*C. racemosa* and *C. chemnitzia*) are available in Kiribati and Samoa. Sea grapes can be cultivated for local consumption [18], and also potentially exported, providing economic opportunity for Pacific Island countries [17], although neither country is involved in cultivation or exports at present. Like other edible seaweeds, sea grapes are a rich source of nutrients, including fiber, vitamin A, iron, and calcium [19–21], thus providing potential to contribute to the nutritional adequacy of Samoan and I-Kiribati people. Given the coexistence of undernutrition and overnutrition in the Pacific region [22], the high fiber and micronutrient content of indigenous sea grapes may potentially offer preventative health solutions. To date, the population consumption practices of seaweed in Pacific Island Countries is not known and will, therefore, be explored in this study. Additionally, the role that sea grapes play in the anthropology of Samoan and I-Kiribati diets is unknown. If seaweeds are a possible positive addition to Pacific Islanders' diets, it is important to first understand if, how, and why these populations are including seaweeds in their diets. Thus, the aim of this study was to undertake an initial exploration of how sea grapes are currently included in Samoan and I-Kiribati diets by quantifying intake and exploring motives for consumption.



**Figure 1.** Location of territorial waters of Kiribati (Tarawa, red dot) and Samoa either side of the equator in the Pacific Ocean, from CartoGIS Services, College of Asia and the Pacific, The Australian National University. [23].

## 2. Materials and Methods

An observational, cross-sectional study design was used to explore the consumption behaviors and role of sea grapes in the current diets of individuals in Samoa and Kiribati. An interviewer-administered survey was used to collect quantitative and qualitative data to analyze consumption behaviors, including the frequency of intake, portion size, and methods of inclusion in the diet. Motives behind participants' decision to consume sea grapes were explored with the purpose of identifying differences between the Samoa and Kiribati populations. Ethical approval was granted by the University of the Sunshine Coast Human Research Ethics Committee (S181186) and local government approvals were granted through the Ministry of Agriculture and Fisheries (Samoa) and the Ministry of Fisheries and Marine Resources Development (Kiribati).

### 2.1. Recruitment

Recruitment for this study was undertaken in two locations, Samoa and Kiribati. This study used a convenience sampling method, whereby intercept interviewer-administered surveys took place with eligible participants in the Apia Fish Market and Fungalei Market (Samoa, June 2018) and in local villages in South Tarawa, Kiribati (June 2019). In both instances, participants were initially approached by a local research assistant from the Ministry of Agriculture and Fisheries in Samoa (four staff) and the Ministry of Fisheries and Marine Resources Development in Kiribati (eight staff), in tandem with a member of the university research team. Participant eligibility was determined by initially asking two questions to confirm that participants were aged 18 years or over and identified as a resident of either Kiribati or Samoa. A participant information sheet was available for participants prior to commencing the interview and participants provided verbal consent to participate in the study. No incentive was provided for participation.

## 2.2. Tool

The interviewer-administered structured survey contained three sections: (1) Demographics, (2) Consumption behaviors, and (3) Motivators for consumption. Demographic questions included gender and age. *Caulerpa* species were referred to in the survey by their common name, sea grapes, acknowledging that the term encompasses multiple species of *Caulerpa* in Samoa and Kiribati including *C. racemosa* and *C. chemnitzia*. Questions on consumption behaviors were informed by the wording used in the Dietary Questionnaire for Epidemiological Studies, Version 3.2 (DQES v3.2, Cancer Council Victoria, Australia) and included two multiple-choice questions: On average, last year how often did you eat sea grapes? (options from never to six or more times a day), and choose the usual portion size of sea grapes that you would eat (with the interviewer showing the participant an actual serve size of sea grapes as sold in the country) on a scale of less than  $\frac{1}{4}$  serving to more than one serving (with interviewer recording amount over one serving). Section 2 also included the questions: Do you eat sea grapes on their own? (yes/no, if not, please describe how you include them in your meals and what else do you eat with them), and are there any traditional meals or dishes that you include sea grapes in? (yes/no, if yes, please describe these traditional dishes and how often would this occur, and how did you learn to prepare these dishes?). Section 3 included questions relating to motivations for eating sea grapes. These questions were informed by a review of the literature which identified key factors influencing food choice and read as follows: Thinking about the factors that influence your decision to eat sea grapes, please rate the level to which you agree with each of the following statements (on a four-point scale of strongly agree to strongly disagree) for: I like the taste, texture, smell, it is nutritious, it is healthy, it is value for money, it is a local food, it is fresh, and it is natural. Participants were also asked one open-ended question: Please describe any other reasons that influence your decision to eat sea grapes. The survey questions were reviewed by the research team for content validity. Additionally, the survey was reviewed by a member of the in-country research team and piloted with five participants in each country, prior to data collection in Samoa and Kiribati. Minor changes were made to wording of questions to ensure culturally appropriate language was used in each country. Researchers and research assistants were provided with in-country training to ensure a consistent process was followed to collect survey data. Surveys took between 10 and 15 minutes to complete. Surveys were completed in English, however, researchers provided the option to verbally translate into the local language (Samoan or I-Kiribati) if the participant chose not to converse in English.

## 2.3. Analysis

Descriptive analysis was completed in Statistical Package for Social Sciences (SPSS version 24, SPSS Inc., Chicago, IL, USA). Demographic data and reported consumption are presented with frequency and proportion for each variable. Likert scale responses regarding motivators for consumption are presented as a proportion of each category. Chi-square analysis was performed to identify associations between nationality and consumption status, consumption status and gender, and consumption status and age.

To determine an average portion size in each country, responses to the question on the usual portion size were assigned a gram equivalent to an average bunch weight of sea grapes (640 g). The average bunch weight of sea grapes is based on data collected by the Ministry of Agriculture and Fisheries (personal communication, June 2018). The average portion size for each eating occasion was subsequently calculated for both Samoa and Kiribati. A Mann-Whitney U test was performed to analyze the difference in portion size between the samples.

Conventional content analysis of qualitative data was performed based on the limited understanding of this phenomenon [24]. Working independently, two researchers (H.B. and L.S.) initially immersed themselves in the data by reading through this repeatedly [24]. Both researchers then identified exact thoughts or concepts and highlighted these on a Microsoft Excel spreadsheet (Microsoft Office 2019), while making notes to describe the initial analysis [24]. From here, code labels emerged from the data and were recorded on the spreadsheet. The codes were then categorized into

categories, based on related thoughts or ideas [24], and then further grouped into meaningful clusters (key categories) [24]. At this point, the researchers H.B and L.S discussed the analysis and resolved any discrepancies in coding. This analysis was completed by two authors (H.B. and L.S.) for triangulation and to increase research rigor. The results of the open-ended questions are presented as key categories, with examples of responses where relevant.

### 3. Results

#### 3.1. Participant Characteristics and Consumption Behaviours

A total of 145 participants completed the interviewer-administered survey, with  $n = 79$  (54.5%) from Samoa and  $n = 66$  (45.5%) from Kiribati. Half (52%) of the total participants in this study (76 of 145) reported consuming sea grapes, with a significantly greater proportion of consumers in Samoa ( $n = 56$ , 70.9%) than Kiribati ( $n = 20$ , 30.3%) ( $p < 0.01$ ). Of those who reported consuming sea grapes, a greater number of these were male ( $n = 47$ , 61.8% vs. female  $n = 29$ , 38.2%). Overall, there was no significant difference in reported consumption across age categories (Table 1).

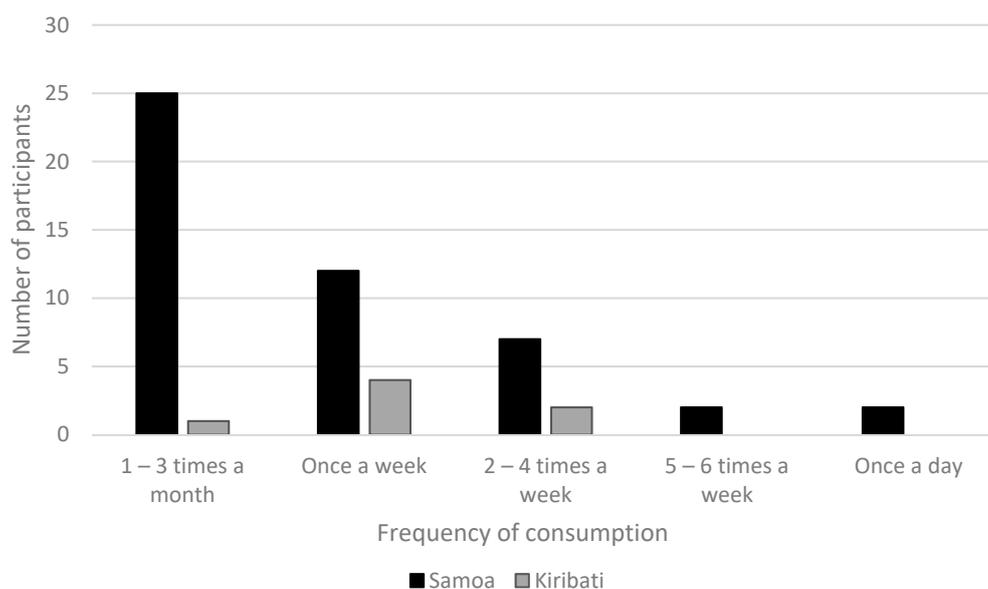
**Table 1.** Participant characteristics in the Samoan and I-Kiribati participants. Raw number and percentage (bracket).

	Samoa n (%)		Kiribati n (%)	
	Consumers * (n = 56)	Non-Consumers (n = 23)	Consumers (n = 20)	Non-Consumers (n = 46)
Sex				
Male	33 (59)	9 (39)	14 (70)	23 (50)
Female	23 (41)	14 (61)	6 (30)	23 (50)
Age (years)				
18–30	9 (16)	7 (30)	6 (30)	8 (17)
31–49	31 (55)	11 (48)	6 (30)	20 (44)
50+	16 (29)	2 (9)	8 (40)	18 (39)
Undisclosed		3 (13)		

\* Greater proportion of consumers in Samoa ( $p \leq 0.01$ ).

Of the participants who reported frequency of consumption ( $n = 55$ ), most reported consumption of sea grapes one to three times a month. No participants reported consumption more than once a day (Figure 2). Self-reported average portion size was larger in Samoa (365 g) than in Kiribati (240 g), but not significantly different ( $p = 0.218$ ).

Conventional content analysis revealed that Samoan consumers primarily eat sea grapes with taro (68.9%,  $n = 31$ ), banana (28.9%,  $n = 13$ ), breadfruit (15.6%,  $n = 7$ ), fish (15.6%,  $n = 7$ ), and other meats (13.3%,  $n = 6$ ). I-Kiribati consumers reported less variety, with consumers reporting fish (55.6%,  $n = 10$ ), breadfruit (50%,  $n = 9$ ) and rice (44.4%,  $n = 8$ ) to accompany sea grapes. Further, most Samoans who reported consuming sea grapes (92.1%,  $n = 35$ ) identified that it is consumed at traditional events or ceremonies, such as weddings, birthdays, and Church services. The I-Kiribati did not associate sea grape consumption with any special events.



**Figure 2.** Frequency of consumption in Samoan and I-Kiribati participants.

### 3.2. Motivators for Consumption

Motivations for sea grape consumption differed between Samoan ( $n = 56$ ) and I-Kiribati consumers ( $n = 20$ ), with a greater proportion of Samoan consumers reporting strong agreement for taste, value for money, and that sea grapes are nutritious, as influences on consumption (Figure 3).

Conventional content analysis of the open-ended questions allowed participants to clarify their primary motivators for eating sea grapes or offer new factors that were not listed in the previous question. Three key categories emerged as motivators: Taste, health, and price. No new factors emerged from the qualitative comments, with the three key categories corroborating quantitative responses in the previous question (Figure 3). In line with quantitative ratings of key motivators (Figure 3), only Samoan respondents qualitatively described the importance of taste as a positive influence on them eating sea grapes ( $n = 33$ , 41.3%), as illustrated through the following quotes:

*“I like the bitter salty taste from the sea.”* [Participant 6, Samoa]

*“It tastes so good and is delicious with taro. I crave it when I see other people eating it.”* [Participant 43 Samoa]

Health and price were important to consumers in both countries (Samoa  $n = 35$ , 43.6%; Kiribati  $n = 14$ , 66.6%), as evidenced through the following quotes (limu is the Samoan name for seaweed):

*“It’s free and healthy.”* [Participant 49, Samoa]

*“It’s good for my throat, the saltiness of limu makes my throat clearer.”* [Participant 20, Samoa]

*“It’s healthier than salt and helps to prevent high blood pressure.”* [Participant 54, Samoa]

*“It’s the number one health food to consume.”* [Participant 7 Kiribati]

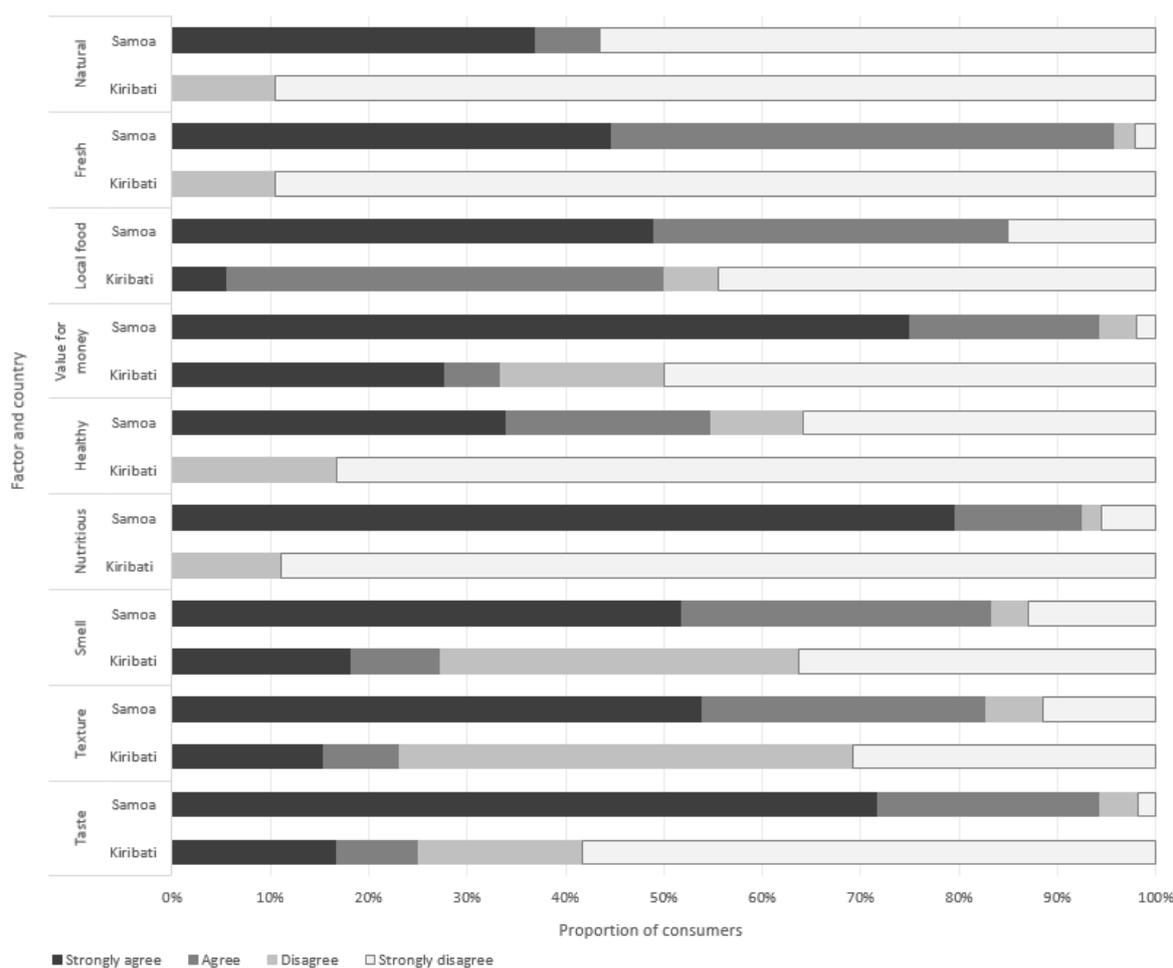


Figure 3. Proportion of Samoan and I-Kiribati consumers and level of agreement of factor as an influence on consumption of sea grapes.

#### 4. Discussion

The aim of this study was to undertake a preliminary exploration of how sea grapes are currently included in Samoan and I-Kiribati diets by quantifying intake and exploring motives for consumption. Our study provides first insights into how the edible seaweed *Caulerpa* (sea grapes) is included in Samoan and I-Kiribati diets. Given the potential that sea grapes may play in contributing to sustainable healthy diets, this understanding makes a valuable contribution to the literature and can inform future practice and policy efforts to support sustainable diets and promote human health. Our findings confirm the complexity of food choice in this setting, as we uncovered multiple intertwined factors that influence sea grape consumption. We found that sea grapes are eaten in both countries, however, consumption is more common, more frequent, and in potentially larger amounts in Samoa compared with Kiribati. Despite being indigenous to both countries, an exploration of consumption practices revealed different motivating factors for consumption.

##### 4.1. Reported Consumption

While only half of all participants reported eating sea grapes, consumption was more likely in Samoans than the I-Kiribati. In both countries, the majority of consumers did not report consumption greater than one to three times per month. As such, it is unlikely that sea grapes contribute substantially to the international targets for specific nutrients [25], despite having a favorable nutrient profile and the portion size being relatively high (365 grams). Samoans also reported consuming sea grapes

alongside a higher variety of foods, such as taro, banana, breadfruit, fish, and meat. Samoans have a preference for high fat, processed foods, which are characteristically high in added sugar and salt [26]. Dietary diversity in Kiribati, on the contrary, is low [17].

Interestingly, despite knowing that seaweeds are indigenous species to the Pacific, readily available for consumption, and have possible health benefits [27], their potential contribution to meeting recommended nutrient intakes is largely unknown. Further investigation to describe how seaweeds fit within a broader diet and the amounts needed to meet recommended nutrient intakes for groups of individuals of different ages and genders is warranted. Sea grapes are an affordable source of nutrients, available locally that could replace less healthy alternatives in the diet. The various motivators identified could be used to inform culturally and geographically appropriate health promotion efforts to help encourage such a change.

#### *4.2. Motivators for Sea Grape Consumption*

Gaining insight into the various interconnecting factors that influence food intake is needed to develop holistic policies and programs that promote sustainable diets. Sensory perception is a known determinant of nutrition and eating [28]. Sensory drivers for consumption, such as taste, texture, and smell, were important to all consumers in our study. To a lesser degree, our study revealed the importance of health and nutrition, and cultural connectedness to sea grapes as key factors motivating consumption for some Samoan participants. Whilst in Kiribati, value for money and local accessibility were more commonly identified as motivators.

#### *4.3. Sensory Drivers for Consumption*

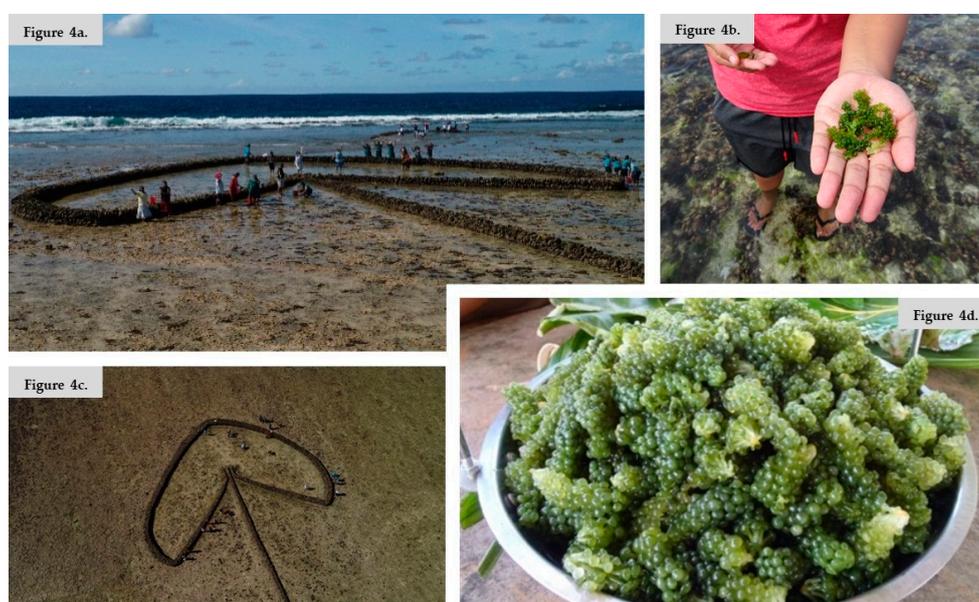
Sensory drivers for consuming sea grapes were important to all participants in our study, however, Samoans were more likely to be motivated by taste compared with the I-Kiribati. Taste as a motivator in food choices in low-middle income countries (LMICs) has not been well researched [2]. Given socioeconomic status is a key determinant of food security [29], it is possible that the difference in taste motivators seen in our sample is due to the greater relative socioeconomic advantage in Samoa compared with Kiribati. Importantly, a positive association between GDP per capita and intake across all food groups has been found, indicating poorer dietary diversity and diet quality in low socioeconomic countries [12]. The prevalence of food security in Samoa and Kiribati is difficult to compare due to a lack of accurate food security data reporting in Kiribati. However, the Global Nutrition Index (GNI) ranks Samoa as more advantaged than Kiribati, with a GNI of 0.681 and 0.650, respectively [30]. While this data is not without its limitations, we postulate that Kiribati is at higher risk of food insecurity, which underpins the lack of emphasis on taste by I-Kiribati consumers. It is possible that motivators for consuming food in Kiribati is driven by satiety, rather than sensory satisfaction. Another possible explanation for this finding is the lower dietary diversity in Kiribati when compared to Samoa [15,17], suggesting that I-Kiribati people are accustomed to having low variety in their diet, and as such, do not seek to diversify in flavor and texture.

#### *4.4. Health and Nutrition*

Samoan consumers identified health and nutrition as one of the motivators in their decision to consume sea grapes. This finding confounds the existing literature, as it is typically those of high socioeconomic status who opt for food choices based on the premise of health [31]. Our study may be limited due to participant bias, as only consumers of sea grapes were asked to identify motivators for its consumption, as such, it is possible that these participants (who currently eat sea grapes) are already more health-conscious. It is also possible that Samoans have a greater awareness of the link between dietary behaviors and health outcomes (health literacy) with Samoans previously reported as having basic knowledge of NCDs [32]. Future research targeting both consumers and non-consumers is warranted to capture both barriers to, and enablers for, sea grape consumption.

#### 4.5. Freshness and Food Access

Freshness was identified by the Samoans as a key motivator for the consumption of sea grapes, which was not the case for I-Kiribati participants. Freshness is a dimension of food access that, alongside other factors within the food environment, are known to influence dietary health [33]. Access and availability of nutritious, culturally appropriate food, key pillars of food security [34], are issues in Kiribati, given its isolated geographical location, poor soil quality, overcrowding, and limited space. Household decisions around food procurement in Kiribati are primarily based on the foods that are accessible and available across seasons [35]. Low dietary diversity in Kiribati is likely due to the limited availability and affordability of nutritious foods [17]. Given the population density and scarcity of fresh food vendors in South Tarawa, the I-Kiribati people may rely on imported processed foods and home food production. A key barrier to fresh food production in Kiribati is the perceived effort of home gardening in comparison to easy access of other imported foods [35]. As a ‘no feed’ crop that does not require exogenous feeding [36], edible seaweeds grow plentifully in oceans and can be cultivated with little or no costs [37]. Involvement in seaweed production can contribute to improved wellbeing through positive economic and social impacts [38]. Given the ready access to reef flats (Figure 4) and the desire of I-Kiribati people to develop new edible seaweed supply chains [39], there is great potential to overcome the barriers of access and availability that currently hinder sea grape consumption in Kiribati. However, currently, we have little understanding of fishery access in Kiribati, as opposed to the long-term monitoring of fisheries (including sea grapes) by the Ministry of Agriculture and Fisheries in Samoan markets. The highly exposed, fringing reef flats common in Kiribati are different from those of Samoan reefs. Revision of ministerial processes to include structured field auditing operations is warranted to determine if, and how, habitat influences the abundance of sea grapes in Kiribati. For this study, the Kiribati samples of sea grapes shown to participants during the survey were collected primarily from walls of the artisanal fish traps on the exposed reefs (Figure 4), which were traditionally owned and cared for by coastal communities to capture fish for their daily sustenance.



**Figure 4.** (a). Kiribati women collecting sea grapes (*Caulerpa chemnitzia*) from the wall and sheltered pools of an artisanal fish trap at Temwaiku village, South Tarawa; (b). Close up of Pacific Island sea grapes (*Caulerpa racemosa*); (c). Harvesting environment, low tide on the reef flat utilizing buckets for collection; (d). Close up of prepared Pacific Island sea grapes (*Caulerpa chemnitzia*).

#### 4.6. Cultural Connectedness

Sea grapes are consumed in a number of locations across the world and are a culturally significant food source in Hawaii, Japan, Indonesia, Malaysia, Fiji, and the Philippines [40]. In our study, Samoan consumers recounted the importance of sea grapes as a local food, that was not evident in Kiribati. In Samoa, the consumption frequency and the inclusion of sea grapes at ceremonial events suggest that it may hold a traditional place within the diet. The association between sea grapes and the Samoan culture may be attributed to the strong food culture in Samoa [41,42]. Most festivities or celebrations are centered around food in Samoa, including the traditional *to'onai* (Sunday lunch), *Lotu Tamaiti* (White Sunday), in addition to weddings, birthdays, village or church meetings. The composition of a meal is reflective of status, for instance, the butchering of a pig or a large deep-sea fish is considered appropriate for *ali'i sili* (High Chief) visits [41]. The nostalgia that Samoan consumers associated with sea grapes was not reciprocated in Kiribati, where consumption was reported to be infrequent and local food and culture did not emerge as a motivator to consume. These results highlighted a key point of difference between the two countries. As Samoan consumers associated sea grapes with a local food that may link to their cultural background and heritage, the I-Kiribati did not. Limited recorded data exist in relation to the role of food in the I-Kiribati culture. The diet is based on seafood, however, due to the low dietary diversity and poorer access to fresh foods [17], it is possible that food does not play a significant role in the I-Kiribati culture in comparison to the Samoan. This insight suggests that a cultural component is important to complement edible seaweed promotion efforts in Kiribati.

Samoan's have repeated exposure to sea grapes through their cultural heritage and attendance at ceremonial events that serve traditional foods. Familiarity with a food is known to increase consumption [43]. Whilst research into Pacific food environments is emerging, it has been found that perceptions of food availability are significantly and positively associated with food acquisition [34]. The culmination of these factors (cultural traditions and familiarity) may potentially be enhancing consumption in Samoa, and lessening consumption in Kiribati. Understanding the cultural drivers underpinning sea grape intake in Samoa offers promising insights that could inform culturally appropriate promotion strategies in Kiribati and elsewhere. Research in Samoa [26,44] and Solomon Islands [45] has demonstrated a preference for local foods. Nostalgic past-focused marketing (as opposed to present-focused marketing) can lead to more favorable brand awareness and greater intent to purchase a product [46]. From a marketing perspective, private companies and the food industry could employ similar strategies whereby advertising is designed to directly elicit feelings of nostalgia that connect consumers to eating sea grapes. Future studies, including qualitative investigations, should explore the factors that would motivate a change in behavior in those who do not consume sea grapes.

#### 4.7. Limitations

There are several limitations to our study. Firstly, our sample size was modest, and our results are not representative of the broader Samoan and I-Kiribati people. Given our sample size, limited statistical analysis was able to be undertaken. As we used an intercept interviewer-administered survey, we did not record those individuals who declined to participate in the survey. However, given the exploratory nature of this work, our descriptive results are novel and provide a starting point for further work to understand seaweed consumption patterns and motivators in Samoa, Kiribati, and the wider Pacific region. Given the cross-sectional nature of our study design, we relied on self-report data and typical bundle size to quantify sea grape consumption. We acknowledge that there are limitations to self-report dietary data and there may be variance in typical bundle size between vendors and over the course of the year. The literature suggests that differences in typical diets exist between urban and rural areas in Samoa and Kiribati [44], so it is likely that further research may find variations in consumption behaviors across these countries, and the broader Pacific region.

#### 4.8. Conclusions

This study provides preliminary findings on seaweed consumption behaviors and motivators in Samoan and I-Kiribati people. In Samoa, the cultural significance of sea grapes is evident through its inclusion in celebratory meals that occur on a weekly or monthly basis. Sea grapes could play an important role in Kiribati to address poor access to and availability of fresh food, as a sustainable diet approach to tackle low dietary diversity, multiple micronutrient deficiencies, food insecurity, and livelihoods.

Future research from a whole-diet approach, with a larger sample size, is warranted to determine the contribution that sea grapes (and other edible seaweeds) have towards improving diet quality and addressing the malnutrition in all its forms. Our exploration of motives for consuming sea grapes provides first insights that can inform the food industry and private companies, as well as future practice and policy efforts to support sustainable diets and promote human health. Our findings also confirm the complexity of food choice in this setting, recognizing the interplay between multiple influences, necessitating the adoption of sociological and anthropological approaches for a robust understanding of dietary motivators in this context.

**Author Contributions:** Conceptualization, L.S., S.B. and N.P.; methodology, H.B., L.S., S.B. and N.P.; formal analysis, H.B., L.S. and S.B.; investigation, H.B., L.S., S.B., K.T., T.E. and U.T.; resources, H.B., L.S. and N.P.; data curation, H.B., L.S., S.B., K.T., T.E. and U.T.; writing—original draft preparation, H.B.; writing—review and editing, L.S., S.B. and N.P.; supervision, L.S., S.B. and N.P.; project administration, L.S.; funding acquisition, L.S. and N.P. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded an Australian Centre for International Agricultural Research (ACIAR) project ‘Diversification of Seaweed Industries in Pacific Island Countries’, grant number FIS/2010/098 (<https://aciarc.gov.au/project/fis-2010-098>), and an internal research grant from the University of the Sunshine Coast. Student involvement in this research was funded by the Australian Government New Colombo Plan.

**Acknowledgments:** This research was conducted as part of an ACIAR project ‘Diversification of Seaweed Industries in Pacific Island Countries’ (FIS/2010/098). We acknowledge and thank our participants for their involvement in this study. We are also greatly appreciative of the support of our local staff from the Kiribati Ministry of Fisheries and Marine Resource Development and the Samoan Ministry of Agriculture and Fisheries. We also acknowledge the hard work and assistance of our dedicated student research volunteers; Charli Ash, Kashmir Lal, Emma Lavelle and Joseph Martin.

**Conflicts of Interest:** The authors declare no conflict of interest.

#### References

1. Kirch, P.V. *On the Road of the Winds: An Archaeological History of the Pacific Islands before European Contact*; University of California Press: Berkeley, CA, USA, 2001.
2. Bottcher, C.; Underhill, S.; Aliakbari, J.; Burkhart, S. Food Purchasing Behaviors of a Remote and Rural Adult Solomon Islander Population. *Foods* **2019**, *8*, 464. [[CrossRef](#)] [[PubMed](#)]
3. Dawe, D.; Ahuja, V.; Bloem, S.; Damen, B.; Martyn, T.; Whiting, L. *Dynamic Development, Shifting Demographics, Changing Diets*; FAO: Rome, Italy, 2018.
4. Matheson, D.; Park, K.; Soakai, T. Pacific island health inequities forecast to grow unless profound changes are made to health systems in the region. *Aust. Health Rev.* **2017**, *41*, 590–598. [[CrossRef](#)] [[PubMed](#)]
5. Phongsavan, P. *Kiribati NCD Risk Factors: STEPS Report*; WHO: Geneva, Switzerland, 2009.
6. FAO. WHO: Sustainable Healthy Diets—Guiding Principles. Available online: <http://www.fao.org/3/ca6640en/ca6640en.pdf> (accessed on 1 September 2020).
7. Branca, F.; Lartey, A.; Oenema, S.; Aguayo, V.; Stordalen, G.R.R.; Arvelo, M.; Afshin, A. Transforming the food system to fight non-communicable diseases. *BMJ* **2019**, *364*, 1296. [[CrossRef](#)]
8. Lim, S.; Vos, T.; Flaxman, A. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990 and 2013: A systematic analysis for the Global Burden of Disease Study. *Lancet* **2010**, *380*, 2224–2260. [[CrossRef](#)]
9. Australia-Oceania: Samoa. Central Intelligence Agency: McLean Langley, Virginia VA, U.S. Available online: <https://www.cia.gov/library/publications/the-world-factbook/geos/ws.html> (accessed on 1 September 2020).

10. Australia-Oceania: Kiribati. Central Intelligence Agency: McLean Langley, Virginia VA, U.S. Available online: [https://www.cia.gov/library/publications/the-world-factbook/geos/print\\_kr.html](https://www.cia.gov/library/publications/the-world-factbook/geos/print_kr.html) (accessed on 1 September 2020).
11. World Bank. World Bank List of Economies. 2014. Available online: <siteresources.worldbank.org/DATASTATISTICS/Resources/CLASS.XLS> (accessed on 1 September 2020).
12. Dave, D.; Doytch, N.; Kelly, I. Nutrient intake: A cross-national analysis of trends and economic correlates. *Soc. Sci. Med.* **2016**, *158*, 158–167. [[CrossRef](#)]
13. Ghattas, H. Food Security and Nutrition in the Context of the Global Nutrition Transition. Available online: <http://www.fao.org/in-action/voices-of-the-hungry/en/> (accessed on 1 September 2020).
14. Snowdon, W.; Raja, A.; Reeve, E.; Fesaitu, J.; Cateine, K.; Guignet, C. Processed foods available in the Pacific Islands. *Glob. Health.* **2013**, *9*, 9. [[CrossRef](#)]
15. Global Nutrition Report. 2018. Available online: <https://globalnutritionreport.org/reports/global-nutrition-report-2018/> (accessed on 1 September 2020).
16. Alkerwi, A. Diet quality concept. *Nutr. Diet.* **2014**, *30*, 613–618. [[CrossRef](#)]
17. Eme, P.; Burlingame, B.; Douwes, J.; Kim, N.; Foliaki, S. Quantitative estimates of dietary intake in households of South Tarawa, Kiribati. *Asia Pac. J. Clin. Nutr.* **2019**, *28*, 131–138.
18. Morris, C.; Bala, S.; South, G.; Lako, J.; Lober, M.; Simos, T. Supply chain and marketing of sea grapes, *Caulerpa racemosa* (Forsskål) J. Agardh (Chlorophyta: Caulerpaceae) in Fiji, Samoa and Tonga. *J. Appl. Phycol.* **2014**, *26*, 783–789. [[CrossRef](#)]
19. Paul, N.; Wegner, A.; Tuart, I.; Tamuera, K.; Teata, T.; Tioti, T.; Tanielu, E. *Biochemical Database and Product Sheets for Seaweeds from Fiji, Samoa and Kiribati*; University of the Sunshine Coast: Queensland, Australia, 2020.
20. Dignan, C.; Burlingame, B.; Kumar, S.; Aalbersberg, W. *The Pacific Islands Food Composition Tables*; FAO: Rome, Italy, 2004.
21. Paul, N.; Neveux, N.; Magnusson, M.; De Nys, R. Comparative production and nutritional value of ‘sea grapes’—the tropical green seaweeds *Caulerpa lentillifera* and *C. racemosa*. *J. Appl. Phycol.* **2014**, *26*, 1833–1844. [[CrossRef](#)]
22. Peng, W.; Mu, Y.; Hu, Y.; Li, B.; Raman, J.; Sui, Z. Double Burden of Malnutrition in the Asia-Pacific Region-A Systematic Review and Meta-analysis. *J. Epidemiol. Glob. Health.* **2020**, *10*, 16–27. [[CrossRef](#)] [[PubMed](#)]
23. CartoGIS Services, College of Asia and the Pacific; ANU: Canberra, Australia. Available online: <http://asiapacific.anu.edu.au/maponline/base-maps/kiribati-pacific> (accessed on 1 September 2020).
24. Hsieh, J.; Shannon, S. Three approaches to qualitative content analysis. *Qual. Health Res.* **2005**, *15*, 1277–1288. [[CrossRef](#)] [[PubMed](#)]
25. *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*; World Health Organization: Geneva, Switzerland, 2002.
26. Farrell, P.; Thow, A.; Schuster, S.; Vizintin, P.; Negin, J. Access to a Nutritious Diet in Samoa: Local Insights. *Ecol. Food. Nutr.* **2019**, *58*, 189–206. [[CrossRef](#)] [[PubMed](#)]
27. Preez, R.; Paul, N.; Mouatt, P.; Majzoub, M.; Thomas, T.; Panchal, S.; Brown, L. Carrageenans from the Red Seaweed *Sarcomena filiforme* Attenuate Symptoms of Diet-Induced Metabolic Syndrome in Rats. *Mar. Drugs.* **2020**, *18*, 97. [[CrossRef](#)] [[PubMed](#)]
28. Stok, F.M.; Hoffmann, S.; Volkert, D.; Boeing, H.; Ensenauer, R.; Stelmach-Mardas, M.; Kiesswetter, E.; Weber, A.; Rohm, H.; Lien, N.; et al. The DONE framework: Creation, evaluation, and updating of an interdisciplinary, dynamic framework 2.0 of determinants of nutrition and eating. *PLoS ONE* **2017**, *12*, e0171077. [[CrossRef](#)] [[PubMed](#)]
29. Lo, Y.; Chang, Y.; Lee, M.; Wahlgvist, M. Health and nutrition economics: Diet costs are associated with diet quality. *Asia Pac. J. Clin. Nutr.* **2009**, *18*, 598–604.
30. Rosenbloom, J.; Kaluski, D.; Berry, E. A Global Nutrition Index. *Food Nutr. Bull.* **2008**, *29*, 266–277. [[CrossRef](#)]
31. Darmon, N.; Drewnowski, A. Does social class predict diet quality? *Am. J. Clin. Nutr.* **2008**, *87*, 1108–1117. [[CrossRef](#)]
32. Bollars, C.; Sørensen, K.; Vries, N.; Meertens, R. Exploring Health Literacy in Relation to Noncommunicable Diseases in Samoa: A Qualitative Study. *BMC Public Health.* **2019**, *19*, 1151. [[CrossRef](#)]
33. Caspi, C.; Sorensen, G.; Subramanian, S.; Kawachi, I. The local food environment and diet: A systematic review. *Health Place* **2012**, *18*, 1172–1187. [[CrossRef](#)] [[PubMed](#)]

34. Turner, C.; Kalamatianou, S.; Drewnowski, A.; Kulkarni, B.; Kinra, S.; Kadiyala, S. Food Environment Research in Low- and Middle- Income Countries: A Systematic Scoping Review. *Adv. Nutr.* **2019**, *19*, 730. [[CrossRef](#)] [[PubMed](#)]
35. Kodish, S.; Grey, K.; Matean, M.; Palaniappan, U.; Gwavuya, S.; Gomez, C.; Iuta, T.; Timeon, E.; Northrup-Lyons, M.; McLean, J.; et al. Socio- Ecological Factors That Influence Infant and Young Child Nutrition in Kiribati: A Biocultural Perspective. *Nutrients* **2019**, *11*, 1130. [[CrossRef](#)]
36. Mahadevan, K. Seaweeds—A sustainable food source. In *Seaweed Sustainability: Food and Non Food Applications*; Elsevier: Cambridge, MA, USA, 2015; pp. 347–364.
37. Pickering, T. Advances in seaweed aquaculture among Pacific Island countries. *J. Appl. Phycol.* **2006**, *18*, 227–234. [[CrossRef](#)]
38. Larson, S.; Stoeck, N.; Fachryc, M.; Mustafa, M.; Lapong, I.; Purnomoe, H.; Rimmer, M.; Paul, N. Women’s well-being and household benefits from seaweed farming in Indonesia. *Aquaculture* **2020**, *530*, 735711. [[CrossRef](#)]
39. Swanepoel, L.; Tioti, T.; Eria, T.; Tamuera, K.; Tiitii, U.; Larson, S.; Paul, N. Supporting Women’s Participation in Developing A Seaweed Supply Chain in Kiribati for Health and Nutrition. *Foods* **2020**, *9*, 382. [[CrossRef](#)] [[PubMed](#)]
40. Wright, A.; Hill, L. *Rearshore Marine Resources of the South Pacific*; International Centre for Ocean Development: Halifax, NS, Canada, 1993.
41. Ministry of Health. *Food and Cultural Practices of the Samoan Community in Australia—A Community Resource*; Metro South Health: Brisbane, Queensland, Australia, 2015.
42. Bindon, J. *Food, Power and Globalization in Samoa*; University of Alabama: Tuscaloosa, AL, USA, 2006.
43. Hough, G.; Sosa, M. Food Choice in Low Income Populations—A Review. *Food Qual. Prefer.* **2015**, *40*, 334–342. [[CrossRef](#)]
44. Jones, A.; Dempewolf, H.; Armstrong, R.; Gallucci, K.; Tavana, N. Staple food choices in Samoa: Do changing dietary trends reflect local food preferences? *Ethnobot. Res. Appl.* **2011**, *9*, 455–462. [[CrossRef](#)]
45. Horsey, B.; Swanepoel, L.; Underhill, S.; Aliakbari, J.; Burkhart, S. Dietary diversity of an adult Solomon Islands population. *Nutrients* **2019**, *11*, 1622. [[CrossRef](#)]
46. Ju, I.; Kim, J.; Chang, M.; Bluck, S. Nostalgic marketing, perceived self-continuity, and consumer decisions. *Manag. Decis.* **2016**, *54*, 2063–2083. [[CrossRef](#)]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).