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Estimating the potential consumption level of amaranth for food security initiatives in Trinidad, West Indies

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Abstract: Most commercially grown produce in the Caribbean is cultivated from imported hybrid seeds. Consumers' preferential demand has caused traditional indigenous vegetables to be edged out by these exotic varieties. In this study, we investigated the patterns of Amaranth (an indigenous vegetable) consumption in Trinidad and Tobago. A structured survey was used to capture information from 678 residents (58% women, 63% aged 21 to 40 years) about current consumption, awareness of nutritional and other benefits, and possible increased future consumption under different circumstances. Most (96%) were aware of amaranth but fewer (66%) of its nutritional value. Only 41%, however, reported consuming it regularly. Still, 80% liked its taste and 78% found it easy to prepare. Chi Square tests revealed significant correlations between some demographics and amaranth use. Exploratory factor analysis of a scale on potential consumption of amaranth yielded two latent multidimensional components. Statistical tests (*t* and ANOVA) of demographic impacts on these factors estimated that income class does not influence use; men and younger people are more conscious of Amaranth's diet potential and taste; older people, afro-Trinidadians and those identifying as Christians would consume more amaranth because of its nutrient benefits and if packaged conveniently, with good storage properties.

ABOUT THE AUTHORS

All the authors are staff members of the University of Trinidad and Tobago. Marcus Ramdwar is a Crop Scientist, while Samantha Chadee and Professor Valerie Stoute, are both Environmentalists. The group has many synergies. Members have worked together several times in the past and plan to continue doing so. Several of this group's activities support Sustainable Development, in particular the targets of Food Security and of recycling waste (as a path to reduced environmental pollution). Among some of these recent activities have been the estimation of the potential consumption of alternative food sources, as in this paper, and the exploration of natural fertilizers for food crops. One such example is the use of a sargassum compost, which allows an environmental pollutant, which has proliferated in marine waters considerably in recent years, to be repurposed, resulting in a reduced environmental impact, in reduced costs of food production, and in an improved sturdiness in some fertilized crops, such as hot peppers.

PUBLIC INTEREST STATEMENT

Most leafy vegetables in Trinidad, a small island developed state, are grown from imported seeds. However, indigenous, naturally growing or wild plants can be a source of nutritious, easily accessible food and have traditionally contributed to the diet of people in rural communities. This study explores the perceptions of a random sample of residents of Trinidad on their current and potential future consumption of Amaranth, one of the very few leafy vegetables where the seeds are not imported and can be sourced locally. Amaranth, compared to other exotic vegetables, is considered to have a higher nutritional value. The study also tests the respondents' awareness of this information and looks at possible measures, including public education about nutritional benefits and provision of good packaging and storage, for making Amaranth a viable commercial food product. The study can provide a framework for comparative studies on the consumption of amaranth and other wild vegetables in other areas of the world.

Subjects: Environment & Agriculture; Food Science & Technology; Area Studies; Behavioral Sciences

Keywords: indigenous vegetables; amaranth; edible wild plants; food security; structured survey; exploratory factor analysis; chi square; *t* and ANOVA tests

1. Introduction

Bharucha and Pretty (2010) have noted that food security is presently dependent on a very narrow variety of cultivated species. According to the Food and Agricultural Organization of the United Nations (Food & Agriculture Organization, 2009), around 30,000 plant species around the world are edible, but of these only 7,000 are used as human food resources. The 23,000 plant species unused as human food constitute a reservoir of unexploited nutrition. In 1996, an FAO global plan of action was adopted for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture by approximately 150 countries. The plan identified improved conservation and use of neglected and underutilized species as one of its 20 main activities (Food & Agriculture Organization, 1996). Many of these unused food plants grow wildly in the natural landscape. Campton (2008) indicated that the word "wild", when applied to plants or plant species, often refers to those which grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems, existing independently of direct human action. The ability of any food to provide nutrients is one of the important components of food security (Mavengahama, McLachlan, & de Clercq, 2013) and, as such, wild plants should not be ignored as a viable food option.

According to Shanley and Luz (2003) billions of people in developing countries use wild edible plants as a source of food because of their low cost. Traditionally, a vast majority of edible wild plants contributed to the diet among the poor especially those in rural communities. Wild edible plants are considered by some to be "safety nets" or an "emergency food supply" to be used when there is not enough food during droughts or famine or not enough money to purchase exotic vegetables (Shackleton, Twine, Hunter, Holding-Anyonge, & Petheram, 2006).

Some farmers in the Caribbean and in many developing countries, because of consumer demand, primarily cultivate non-indigenous or exotic vegetable crops (Maundu, 1995). Many of these are from the *brassicaceae* and *solanaceae* plant families. The availability of these commodities as a source of food is much dependent on certified seed imports and/or on the importation of the commodity itself. (In some instances, open-pollinated and heirloom varieties are cultivated.) However, given the impending impact of climate change on crop production, there is existing pressure on exotic crops, creating an urgent need to explore alternative crops, which have the potential to replace and satisfy the demand for food (Rastogi & Shukla, 2013). Wild edible plants are expected to provide options for screening species which are likely to be best adapted to climate change and to become means of sustenance (Feyssa, Njoka, Asfaw, & Nyangito, 2011). Additionally, edible wild plants are less prone to stresses and plant diseases, compared to exotic vegetables, and can have a positive impact of sustaining food security. Currently, though, wild edible plants themselves are under threat of extinction from urbanization, natural habitat destruction, agricultural intensification, pesticide use, and slash and burn agricultural practices. Deliberate attempts should be made to preserve this valuable food source.

Amaranth belongs to the family Amaranthaceae, for which approximately 60 species are presently recognized (The Royal Horticultural Society, 2008). In the Caribbean, the leaves are called spinach bhaji or bhaji in Trinidad and *Callaloo* in Jamaica, and are stewed with onions, garlic and tomatoes, or sometimes used in a soup called pepperpot soup (Costea, Tardif, & Brenner, 2003). Amaranth (*Amaranthus spp*.) in Trinidad is cultivated and consumed as a leaf-type vegetable although in some areas of the world it is cultivated for its grain as well. The cultivation of amaranth in Trinidad is not

as widespread as other leaf-type exotic vegetables from imported origins. The plant is also a common weed which is popularly found in crop production fields and growing randomly in marginal areas where exotic vegetables struggle to survive (Vorster, Jansen van Rensburg, & Venter, 2007). Given the wild ubiquitous nature of this plant species it can be harvested and used as a source of food (Achingan-Dako, Sogbohossoe, & Maundu, 2014). Amaranth produces a large amount of biomass in a short period of time (Kauffman & Weber, 1990) and therefore has the potential to contribute to a substantial increase in world food production.

Indigenous vegetables like amaranth have been shown to have a relatively high nutritional value compared to the exotic vegetables (Burlingame, 2000; Chweya & Eyzaguirre, 2008). The leaves are rich in calcium, phosphorus, folic acid, potassium, iron and vitamins A, B and C but fairly low in carbohydrate (Asian vegetable Research & Development Centre (AVRDC) - The World Vegetable Center, 2003; Okpara et al., 2013; Priya, Celine, Gokulapalan, & Rajamony, 2007). Compared to lettuce, amaranths can contain 18 times more vitamin A, 13 times more vitamin C, 20 times more calcium and 7 times more iron (Guillet, 2004). The nutrient content per 100 g fresh weight of amaranth, compared to cabbage, is much higher in protein (4.0 vs. 1.4%), calcium (480 vs. 44 mg), iron (10 vs.0.8 mg), β-carotene (10.7 vs.1.2 mg) and vitamin C (135 vs.33 mg) (Waithaka & Chweya, 1991). See also some specifics for the nutrient values in raw and cooked amaranth in Table 1.

Additionally, amaranths are recommended as a good food with medicinal properties for pregnant women, children, lactating mothers, and patients with constipation, fever, haemorrhage, and anaemia and may help to boost immunity among HIV patients (Muthaura et al., 2007; Quinton, 2006). Edible wild plants, like amaranth, have been reported to be the new millennium crops of nutriceutical value (Rastogi & Shukla, 2013). Such plants contain high contents of phytochemicals such as phenolic compounds, including flavonoids, which have strong antioxidant properties known to be associated with the prevention of age-related diseases such as cancer, arteriosclerosis, and diabetes (Neudeck et al., 2012).

This study investigates the current consumption patterns of respondents in Trinidad and their willingness, under various circumstances, to consume amaranth in the future, even if they do not now, or to consume more than they currently do.

Table 1. Nutritional value of raw and cooked (boiled, drained, without salt) amaranth leaves, compared with raw cabbage

Nutrients/leafy vegetable	Value per 100 g		
	Cabbage, raw	Amaranth, raw	Amaranth, cooked
Protein (g)	1.28	2.46	2.11
Calcium (mg)	40	215	209
Iron (mg)	0.47	2.32	2.26
Magnesium (mg)	12	55	55
Phosphorus (mg)	26	50	72
Potassium (mg)	170	611	641
Manganese (mg)	0.160	0.885	0.861
Vitamin C (mg)	36.6	43.3	41.1
Riboflavin (mg)	0.04	0.158	0.134
Niacin (mg)	0.234	0.658	0.559
Vitamin A (mg)	5	146	139

Source: U.S. Department of Agriculture, Agricultural Research Service (USDA), USDA Nutrient Data (2010).

2. Methodology

A structured survey was administered online using Survey Monkey®. Potential participants were able to access the survey link via a notifying email, sent to various organizations around the country, as well as via messages on Facebook, WhatsApp, and Twitter. The link was accompanied by a spiel which described the study, included a picture of the amaranth plant, and identified some of its purported benefits. Respondents were incentivized by the prospect of being entered into a draw for one of three main prizes. Contact information was collected in a file separate from the survey responses so that anonymity was preserved. Care was taken to explain this to potential respondents. Note that online administration is considered to provide the best access in Trinidad and Tobago, where there is large mobile phone penetration, estimated to be roughly 1.5 phones for every member of the population or 2 or 3 mobile phones for the average adult, with at least one of them smart.

Other than basic demographics, respondents were asked to identify places where they would expect to purchase bhaji, about their knowledge of the preparation of and demand for it, and about their consumption habits with regard to bhaji and its taste appeal. Finally, using an interval scale from "0" to "5", respondents were questioned on what marketing and packaging features would most likely prompt them to purchase and/or use more bhaji.

The categorical questions are summarized in a matrix of frequency distributions or ranked in terms of awareness. The means and standard deviations are estimated for the scale questions and tabulated as decreasing means. Reliability of the survey scale was estimated from its Cronbach alpha value. That analysis, the Exploratory Factor Analysis (EFA) of the scale items, using Principal Component extraction and Varimax rotation, chi square tests for correlation between demographic and perception variables, and *t* and ANOVA tests of the demographic impacts on perceptions were all carried out using the statistical software SPSS V.22.

3. Results and discussion

3.1. Demographics of respondents

The survey was answered by 678 individuals. The details are summarized in Table 2. The bulk of respondents (74%) came from three counties—St George, Caroni, and Victoria- with most of them being women (58%); between 21 and 40 years old (63%); ethnically Indian (45%) or African (24%) or mixed (26%); Christian (58%) or Hindu (23%); and self-designated as being in an economic bracket of upper middle (39%) or lower middle (53%) class.

3.2. Amaranth purchase, consumption, awareness patterns

Almost everyone responding (96%) was aware of amaranth. Whether or not they had consumed it before, individuals felt that it would be most convenient to them to purchase it from Municipal markets (34%), supermarkets (14%) or community vegetable markets (13%) - Table 3. Almost one-fifth (18%) of the respondents grow the vegetable in their home gardens. What the data in Table 3 illustrates is that this vegetable is somewhat accessible to those who want to consume it but could still be made more so since only a little more than half agreed that it was as easily available to purchase as others. Although the sample was predominantly (92%) non-vegetarian, there was still a substantial percentage (41%) of respondents who reported that they consume it every two weeks or even more frequently. The items in Table 4 poll the respondents in three areas- (1) the appeal of this vegetable, (2) awareness of its benefits, and (3) perceptions about relative price and demand. We note that most respondents felt the vegetable was relatively easy to prepare (78%), ate it most often with a staple such as rice or a flour product (86%), and liked the taste of it (80%). Most could understand, without knowing before, that because bhaji can be grown with less chemicals, it would be safer to eat (80%). However, far fewer people were aware of amaranth's nutritional benefits (66%) or of which leaves, younger or older, were better for consumption (64%). Respondents feel even less that the vegetable is as easily available for purchase as others (58%). They were not sure about its relative price since only 47% agreed it was cheaper and even fewer (33%) agreed it was perceived

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Table 2. Frequency distributions of respondents' demographics

Variable	Category	Frequency (%)
Area	St. George	33
	Caroni	24
	Victoria	17
	St. Andrew	7
	St. Patrick	7
	St. David	2
	Nariva	2
	Mayaro	1
	Tobago and Caribbean	7
Sex	Men	42
	Women	58
Age	16–20 years	16
	21–30 years	40
	31–40 years	23
	41–50 years	12
	51–60 years	7
	Older than 60 years	3
Ethnicity	Afro-Trinidadian	24
	Indo-Trinidadian	45
	Chinese-Trinidadian	0.3
	White	0.9
	Mixed	26
	Other	3
Religion	Christian	58
	Hindu	23
	Muslim	7
	Rastafarian	1
	Other	11
Income class level	Upper class	2
	Upper middle	39
	Lower middle	53
	Lower class	6
Dietary consumption category	Vegetarian	8
	Non-vegetarian	92
Frequency of consumption	Twice per week	5
	Once per week	19
	Every two weeks	17
	Once per month or less	59

Table 3. Most conveniently accessible outlets for bhaji purchases

Outlets for bhaji purchase	Frequency (%)
Municipal markets (Tunapuna, Arima, Central, Port-of-Spain)	34
Home garden	18
Supermarket	14
Community vegetable mini-type markets	13
Farmers market	9
Road side produce vendors	8
From the farmers directly (farm gate)	1
Other outlets	3

Table 4. Current awareness and use of bhaji

Bhaji item statements	Frequency (%)		
	Yes	No	DK
I eat "Spinach bhaji" *most often* with a staple (rice or flour based product)	86	13	1
I generally like the taste of "spinach bhaji"	80	19	1
"Spinach bhaji" is easily prepared for consumption	78	13	9
If "Spinach bhaji" can be easily grown with low inputs of agro-chemicals (fertilizers and pesticides), it should be safer to eat than other leafy types of vegetables	80	2	18
I was aware before today of the greater nutritional benefits associated with consuming "spinach bhaji" compared to consuming other types of leafy vegetables available in Trinidad	66	29	5
Younger leaves are preferred to older leaves for cooking purposes	64	6	30
"Spinach bhaji" is as readily available to purchase as other leafy types of vegetables	58	25	17
Compared to other leafy vegetables, "*spinach* bhaji" is cheaper	47	20	33
There is a perception that "*spinach* bhaji" is a food source for poor people	33	45	22
There is a greater demand for "*spinach* bhaji" than for other leafy vegetables	10	39	51

as a food for poor people. Very few people (10%) felt that there was a bigger demand for amaranth than for other leafy vegetables.

Each of the maps in Figures 1 and 2 capture the summed "yes" frequencies of two questions, in one case reflecting "Taste" (Figure 1) and, in the other, "Awareness of Benefits" (Figure 2) for the eight (8) counties of Trinidad, coalesced into 6 for convenience. (We were primarily interested in Trinidad and not Tobago, although some people originally from Tobago but residing in Trinidad did respond to the survey.) Most of the respondents from the counties of St Patrick (7%), Victoria (17%), and St Andrew (7%) both like the taste of bhaji and are aware of its benefits. Respondents to these questions from the larger counties like Caroni (24%) and St George (33%) are near the bottom of the order in both cases, probably because with very large numbers of respondents, there is a bigger likelihood of incorporating some individuals with low scores which will reduce the average value. The important difference between the two orders is that the order of "Taste" is quite tightly bunched going from 1.74 to 1.86, out of a possible 2, but the average summed frequencies for "Awareness of Benefits" are spread from 1.0 (Mayaro) or 1.34 (if summed with Nariva) to 1.68 (St Patrick). The disparity in awareness suggests that this is one area where efforts to increase the use of indigenous vegetables may pay dividends if there is a campaign to educate the public, particularly in some counties, about the benefits of use to be gained in reduced cost and improved nutrition. Looking at

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Figure 1. Taste values in different counties in Trinidad.

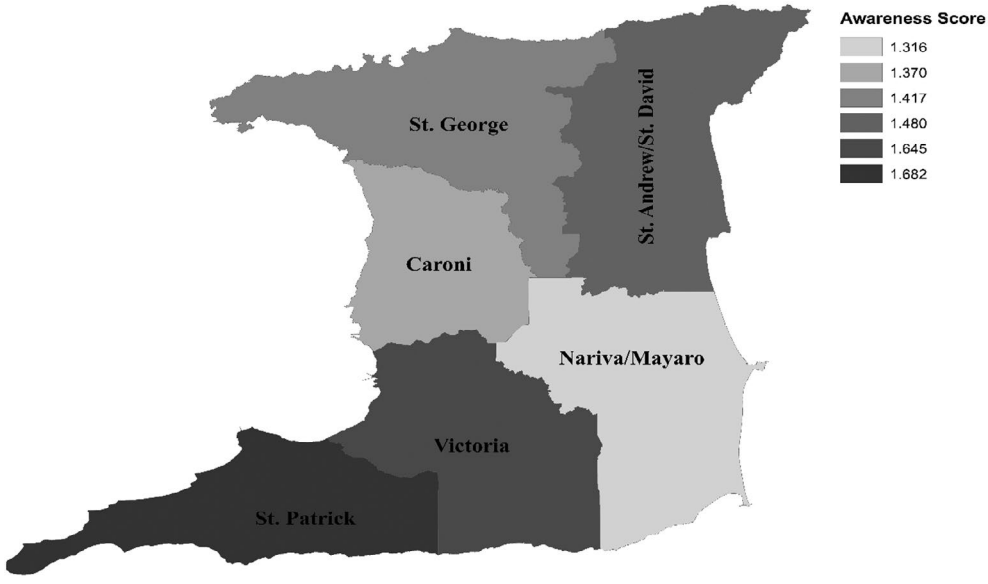

Figure 2. Awareness score for different counties in Trinidad.

Table 3, such a campaign should focus as well not just on use but on optimal use (for example, selecting younger leaves).

3.3. Potential for future enhanced bhaji consumption

The survey scale items attempt to capture future contexts which would promote consumption. The scale is designed using a contingent valuation format in that the respondents are polled on "willing to consume" in the future, contingent on certain contexts of awareness of benefits, availability, preparation, storage, and packaging of the amaranth, and whether or not it could work in a weight

loss diet. The information, gained from looking at the mean responses for these items and at the Factor themes from EFA, reinforces what was observed from the responses in Table 4. In Table 5, the top three mean responses are for the items which relate to awareness of chemical residues on the plant (3.53), medical benefits (3.35), and nutritional benefits (3.29). These items also have the smallest standard deviations. Mean values estimate the intensity of the emotion, in this case agreement with the particular scale statement. The standard deviation, on the other hand, represents consensus or agreement among the responses given. From both statistics, these three statements elicit the strongest and most reliable responses. Statements on availability (3.21), preparation (2.95), and packaging (2.74) follow in order of importance. It should be noted that packaging with preparation instructions (2.49) is not considered much of an incentive for promoting future consumption. Other less important triggers for more current and so future consumption would be if it could be shown to have a weight loss effect (2.68) and if a taste for it had been developed earlier (2.61).

The orthogonal Factors, extracted from the survey scale, support what is seen from the means. Two Factors, which together explain 60.3% of the variance in the scale scores, are extracted using Principal Component Analysis followed by Varimax rotation. The scale itself was found to be very reliable, with a Cronbach alpha value of 0.869. All items contribute to the scale. The EFA yields a good solution with high anti-image correlation diagonal elements (AIC diagonal elements of 0.798 to 0.937), a Kaiser-Meyer-Olkin (KMO) statistic for sampling adequacy of 0.857, and a significant Bartlett's test of Sphericity ($\chi^2 = 2819$, $p = 0.000$). The main Factor explains nearly 44% of the variance in scale scores and captures elements of awareness of benefits and convenience—all the items with high scale means. All of the elements of availability, packaging, easier storage etc. are strongly correlated with the first Factor, with loadings from 0.74 to 0.79 - Table 6. The second orthogonal Factor, which explains approximately 17% of the variance in the scale scores, far less than the main Factor does, is strongly associated (loadings of 0.79 and 0.86) with the two statements on diet and taste.

It should be noted that Factors capture the areas of common thinking among the members of a sample. Factors do not indicate how the respondents are thinking. This information is obtained from the means. In this sample, all the statements with the highest means load heavily on the first Factor.

Table 5. Possibilities for enhancing bhaji consumption

Scale items	Mean	SD
I would consume more bhaji…		
If I was assured that it had less chemical residues than other leafy vegetables	3.53	1.61
I was educated more about its medical benefits for anemia, diabetes etc	3.35	1.68
I was educated more about its overall nutritional benefits	3.29	1.62
It was readily available at the food stores/ markets I frequent	3.21	1.64
It could last longer in storage (postharvest stability) before cooking	2.98	1.65
It were cleaned and prepped before packaging	2.95	1.79
It was packaged with recipes for different dishes	2.74	1.92
If I had to be on a calorie reducing diet to lose weight	2.68	1.80
If I had developed a taste for it at an earlier age	2.61	1.81
It was packaged with clear preparation instructions	2.49	1.86

Table 6. Latent quantitative themes of conditions for enhanced bhaji consumption

Factors	Scale items	Factor loadings
	I would consume more bhaji…	
Factor 1-Awareness and convenience (of access, packaging and storing) 43.8%	I was educated more about its overall nutritional benefits	0.666
	I was educated more about its medical benefits for anemia, diabetes etc	0.696
	It was readily available at the food stores/markets I frequent	0.722
	It was packaged with clear preparation instructions	0.789
	It was packaged with recipes for different dishes	0.756
	It could last longer in storage (postharvest stability) before cooking	0.760
	It were cleaned and prepped before packaging	0.736
	If I was assured that it had less chemical residues than other leafy vegetables	0.756
Factor 2-Taste and nutrition 16.5%	If I had developed a taste for it at an earlier age	0.861
	If I had to be on a calorie reducing diet to lose weight	0.786
Cronbach alpha = 0.869, AIC diagonal elements = 0.798–0.937; KMO = 0.857, χ^2 = 2,819, p = 0.000		

This suggests that, with regard to the issue of promoting consumption, the largest area of common thinking among respondents is in the features of awareness of benefits and convenience of availability, storage, and packaging. They also feel most strongly, given the values of the means that focus on these areas could lead to increased consumption.

3.4. Associations between demographics and categorical perceptions

The questions eliciting categorical responses are meant to map the landscape of consumption of amaranth and awareness of its benefits and availability, whereas the scale items explore possible triggers for promoting preferential use of this indigenous vegetable. Associations were tested, by chi square tests of independence, between the demographic variables and categorical response questions, which include whether or not respondents currently consume or know bhaji; how often it is consumed; whether they like the taste of it; if they were aware of the nutritional benefits; if they would consider it safer to eat than other vegetables if it is known that it can be grown easily without pesticides or fertilizers; and whether they found it readily available to purchase. The groups of variables which are paired in the chi square tests are shown in Table 7.

The significant associations from the chi square tests at the 5 and 10% critical levels are shown in Table 8. All of the demographic variables (column one in Table 7), except sex, are associated with at least one of the variables in column 2. Men and women are not statistically different in their consumption patterns, in whether or not they like the taste of bhaji, or in their awareness of its benefits and availability. On the other hand, older people eat/know bhaji and like the taste of it significantly

Table 7. Variable pairs used in the chi square tests of associations

Variable 1 (demographics)	Variable 2 (demographics and perceptions)
• Sex • Age • Ethnicity • Religion • Income level	• Consumption • Have you ever eaten/do you know Bhaji • I like the Taste • If "Spinach bhaji" can be easily grown with low inputs of agro-chemicals (fertilizers and pesticides), it should be safer to eat than other leafy types of vegetables • I was aware before today of the greater nutritional benefits associated with consuming "spinach bhaji" compared to consuming other types of leafy vegetables available in Trinidad • Available to purchase

Table 8. Significant chi square associations of demographic and perception variables

Demographic	Perception/question	*p*-value		Trend
		$\alpha = 0.05$	$\alpha = 0.10$	
Sex	None	–	–	–
Age 16–20/21–30/31–40/41–50/51–60/61 and over	Eaten/know	0.048		The oldest age group was aware completely. Age group with lowest awareness was the 21 to 30 years group
	Like the taste		0.053	Percentage of those who said "yes" increases monotonically with age from 70% in youngest group to 90% in last two age groups
Ethnicity African/Indian/mixed/other	Aware of nutritional benefits	0.018		Indians were more aware before than other ethnic groups of the nutritional benefits
	Safer without agrochemicals	0.012		Indians believed this significantly more than other ethnic groups did
	Consumption	0.000		Indians were the largest % in the top three consumption levels – twice a week, once per week, and every two weeks
Religion Christian/Hindu/Muslim/other	Eaten/Know	0.004		Muslims first and then Hindus were significantly more aware of or have eaten bhaji significantly more than Christians
	Consumption	0.000		Hindus first and then Muslims stood out significantly from Christians in their consumption % in the top levels of twice per week, once per week, and every two weeks
Income class Upper/upper middle/middle/lower	Aware of nutritional benefits	0.033		Respondents who identified their income level as upper or upper middle class were significantly more aware of the nutritional benefits of bhaji than those in the lower income classes
	Consumption		0.060	Respondents who identified their income level as upper (60%) or upper middle class (26%) were the highest consumers of bhaji compared with the other two groups (21%), consuming it once or twice per week

more than those in younger age groups. Ethnic Indians, of all the races, are significantly the chief consumers of bhaji and are most aware of both its nutritional benefits and the fact that it can be grown easily without too many pesticides or fertilizers. In terms of consumption, religion follows race in that Muslims and Hindus eat significantly more bhaji than other religions. However, they do not stand out from Christians in awareness of its benefits or in any of the other areas tested. The associations with class are surprising in that respondents who identify themselves as having upper or upper middle class incomes are more aware of the nutritional benefits of bhaji and eat significantly more of it.

3.5. Demographic impacts on scaled perceptions

The single survey scale polls respondents' perceptions of which efforts would lead to increased or more regular use of bhaji in Trinidad and Tobago. The tacit assumption here is that this would result in the substitution in local diets of this indigenous vegetable for the imported varieties, reaping benefits in improved food security and in costs. The EFA yielded two Factors – one which incorporates those efforts to educate the public about nutritional and other benefits of bhaji and on the advantages of creative packaging and greater availability. The other captures promoting a taste for bhaji

Table 9. Demographic impacts on scale factor scores-*t* and ANOVA tests

Demographic	Scale factor	*p*-value	Trend
Sex	Taste and nutrition	0.008	Males had a significantly higher mean value
Age 16 −30 years/31 −50 years/51 years and over	Awareness and convenience	0.040	The oldest group of respondents scored highest on this Factor. The mean increased significantly with age
	Taste and nutrition	0.010	The youngest group of respondents scored most highly on this, significantly different from the other two age groups which were statistically equal
Ethnicity African/Indian/mixed/other	Awareness and convenience	0.021	Respondents who identified themselves as ethnically African scored highest on this, significantly more so than any of the other groups which were not distinguishable from each other
Religion Christian/Hindu/Muslim/other	Awareness and convenience	0.042	Christians scored highest on this, significantly more than the other groups which were similar
	Taste and nutrition	0.017	Christians, Muslims, and Hindus were not significantly different from each other. It is the "other" group which stands out in this test so this is somewhat uninformative
Income class	–	–	–

early and advertising it as a way or reducing calories in one's diet. Together these Factors represent the latent multivariate common thinking underlying the manifest responses for the actual scale items. All individual variance is eliminated from the scale Factors. Hence, the impacts of demographics are tested not with the original scale item scores but with these multivariate themes as dependent variables. ANOVA (for age, ethnicity, religion, and income class as independent variables) and t tests (for sex as the grouping factor) were carried out with the saved EFA Factor scores as dependent variable values. The results are summarized in Table 9. Men, the youngest respondents, and individuals who identify themselves as something other than Christian, Hindu, or Muslim have significantly higher means on the *Taste and Nutrition* Factor, suggesting that they more than others put focus on the areas of encouraging a taste for the product and prompting it as a dietary supplement for increasing bhaji use locally. On the other hand, older people, Afro-Trinidadians, and Christians have higher means on the *Awareness and Convenience* main Factor, illustrating that their thinking is more in the area of building awareness, employing good packaging, and increasing availability at various outlets as measures for enhancing future use.

4. Conclusion

Food security is as much a quantitative concept, particularly in the areas of food availability and accessibility, as it is qualitative in terms of our food supplying essential nutrients in well balanced diets (Food & Agricultural Organization, 2008). The sustainable use of indigenous food crops such as amaranth can provide a nutritious alternative to exotic leafy vegetables and support food security initiatives. This study attempted to summarize the current local bhaji use patterns and to gauge awareness of benefits as well as the mean responses of survey participants to several suggested initiatives which could increase the success of a possible nationwide programme to substitute viable local alternatives for expensive imports.

The research shows that, in this random sample, most people (96%) were currently aware of amaranth, liked its taste (80%), and believed it is easy to prepare (78%), though not all were aware of its

nutritional benefits (66%), or of its ability to grow and thrive without excessive applications of fertilizer and pesticides (making it possibly safer than most imported varieties, even those grown here from imported seeds), or of its post-harvest stability, which leads to better storage. There also seems to be a problem with knowing (only 58%) where the vegetable is available for purchase. The respondents' demographics correlate significantly with their perceptions in certain instances and with their consumption habits. Appreciation of the taste of bhaji is more frequent with age, with 90% of the oldest respondents (compared with 70% of the youngest) who liked the taste of bhaji. Indians (Hindus and Muslims) and individuals with upper or upper middle class incomes disproportionately (relative to the other groups) consume bhaji, eating it significantly more - at least once and sometimes twice a week. These two groups (Indians and high income groups) are also more frequently aware than others of the nutritional benefits of bhaji. Demographics, as emphasized in the last section, impact on respondents' perceptions, scored on the survey scale, of which efforts will promote increased use. The oldest group of respondents, people of African origin, and Christians have the highest means (of all the categories in their respective areas) on the *Awareness and Convenience* Factor scores. As pointed out earlier, Factors, extracted during EFA, actually measure the focus of common thinking but not necessarily how one is thinking in that area. (Note, though, that with this scale, the first Factor correlated with the statements with the highest means, and the second with those which respondents considered of less importance in promoting consumption). Hence, the "thinking" for these demographic groups, in the area of efforts to increase bhaji use, rests on issues of building public awareness through education about the benefits and value of the vegetable, along with the convenience of creative and effective packaging and its ready availability at popular outlets. On the other hand, other demographics impacted the second Factor- *Taste and Nutrition*. The thinking of men and the youngest respondents, more than that of women or older individuals, focused on efforts, which could build into individuals early a taste for bhaji, and those initiatives which could promote it as a low calorie but nutritious food.

The annual food import bill, which includes exotic vegetables, for Trinidad and Tobago in 2013 was estimated at TT$4 billion (approx.US$620.2 million). Food import dependence implies vulnerability to external food supply shocks which are likely to increase because of rising volatility in food markets, related to climate change, growing resource scarcity (as with land and water), rising prices for energy and agro-chemicals, increased demand for bio-fuels, and population growth (World Bank, 2007). The consumption of amaranth can provide a buffer from increasing possible food scarcity threats to Trinidad and Tobago. This paper provides the basic information and insights into national thinking on which decision makers can build.

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References

Achingan-Dako, E., Sogbohossoe, O. E. D., & Maundu, P. (2014). Current knowledge on *Amaranthus spp.*: Research avenues for improved nutritional value and yield in leafy amaranths in Sub-Saharan Africa. *Euphytica, 196*, 213–225.

Asian vegetable Research and Development Centre (AVRDC) - The World Vegetable Center. (2003). *AVRDC progress report 2003* (No. 04-599). Shanhua: Author.

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365*, 2913–2926. https://doi.org/10.1098/rstb.2010.0123

Burlingame, B. (2000). Wild nutrition. *Journal of Food Composition and Analysis, 13*, 99–100. https://doi.org/10.1006/jfca.2000.0897

Campton, R. (2008). *The economic value of wildlife in Eastern and Central Africa* (No. Research Paper No: 23). Tanzania: Institute of Development Studies (IDS), University of Dar es Salaam.

Chweya, J., & Eyzaguirre, P. (2008). *The biodiversity of traditional leafy vegetables*. Rome: International Plant Genetic Resources Institute.

Costea, M., Tardif, F. J., & Brenner, D. M. (2003). The identity of a cultivated *amaranthus* from Asia and a new

nomenclatural combination. *Economic Botany, 57*, 646–649. https://doi.org/10.1663/0013-0001(2003)057[0646:NOEP]2.0.CO;2

Feyssa, D. H., Njoka, J. T., Asfaw, Z., & Nyangito, M. M. (2011). Seasonal availability and consumption of wild edible plants in semiarid Ethiopia: Implications to food security and climate change adaptation. *Journal of Horticulture and Forestry, 3*, 138–149.

Food and Agriculture Organization. (1996). *Global plan of action for the conservation and sustainable utilization of plant genetic for food and agriculture and Leipzig declaration adopted by the international technical conference on plant genetic resources, Leipzig, Germany*. Rome: Author.

Food and Agricultural Organization. (2008). *An introduction to basic concepts of food security. Food security information for action. Practical guides*. Rome: The European Commission - Food and Agricultural Organization Food Security Programme.

Food and Agriculture Organization. (2009). *How to feed the world in 2050*. Rome: Author.

Guillet, D. (2004). *Grain amaranthus, history and nutrition. Kokopelli seed foundation*. Retrieved from http://www.kokopelli-seed-foundation.com/amaranths.htm

Kauffman, C. S., & Weber, L. E. (1990). Grain amaranth. In J. Janick & J. E. Simon (Eds.), *Advances in new crops* (pp. 127–139). Portland: Timber Press.

Maundu, P. M. (1995). The status of traditional vegetable utilization in Kenya. Conservation and use. *Proceedings of the IPGRI International Workshop on Genetic Resources of Traditional Vegetables in Africa* (pp. 23–30). Nairobi: National Museum of Kenya.

Mavengahama, S., McLachlan, M., & de Clercq, W. (2013). The role of wild vegetable species in household food security in maize based subsistence cropping systems. *Food Security, 5*, 227–233. doi:10.1007/s12571-013-0243-2

Muthaura, C. N., Rukunga, G. M., Chhabra, S. C., Omar, S. A., Guantai, A. N., Gathirwa, J. W., … Njagi, E. N. (2007). Antimalarial activity of some plants traditionally used in Meru district of Kenya. *Phytotherapy Research, 21*, 860–867. https://doi.org/10.1002/(ISSN)1099-1573

Neudeck, L., Avelino, L., Bareetseng, P., Ngwenya, B. N., Demel, T., & Motsholapheko, M. R. (2012). The contribution of edible wild plants to food security, dietary, diversity and income of households in Shorobe village, Northern Botswana. *Ethnobotany Research and Applications, 10*, 449–462.

Okpara, S. C., Onyegbule, U. N., Nwanguma, E. I., Ibekwe, H. N., Ngbede, S. O., & Uwalaka, O. A. (2013). Effect of different fertilizer forms on the growth and yield of amaranths (*Amaranthus cruentus*) in Okwigwe, Southeastern Nigeria. *Horticultural Society of Nigeria (HORTSON) Book of Abstract 31st Annual Conference* (86). Abuja: Raw materials Research and Development Council.

Priya, V. S., Celine, V. A., Gokulapalan, C., & Rajamony, L. (2007). Screening amaranth genotypes (*Amaranthus spp*.) for yield and resistance to leaf blight caused by *Rhizoctonia solani* Kuhn. *Plant Genetics Research News, 147*, 1–4.

Quinton, I. (2006). *Indigenous spinach. Go farming for the farmers of tomorrow*, 20–21.

Rastogi, A., & Shukla, S. (2013). Amaranth: A new millennium crop of nutraceutical values. *Critical Reviews in Food Science and Nutrition, 53*, 109–125. https://doi.org/10.1080/10408398.2010.517876

Shackleton, S., Twine, W., Hunter, L., Holding-Anyonge, C., & Petheram, L. (2006). Forests as safety nets for mitigating the impacts of HIV/AIDS in Southern Africa. *Forest Livelihood Briefs, 4*(1).

Shanley, P., & Luz, L. (2003). The impacts of forest degradation on medicinal plant use and implications for health care in Eastern Amazonia. *BioScience, 53*, 573–584. https://doi.org/10.1641/0006-3568(2003)053[0573:TIOFDO]2.0.CO;2

The Royal Horticultural Society. (2008). In C. Brickell (Ed.), *A-Z encyclopedia of garden plants*. London: DK Publishing.

U.S. Department of Agriculture, Agricultural Research Service (USDA), USDA Nutrient Data. (2010). *USDA national nutrient database for standard reference, Release 23*. Washington, DC: Author.

Vorster, I. H. J., Jansen van Rensburg, W. S., & Venter, S. L. (2007). The importance of traditional leafy vegetables in South Africa. *African Journal of Food Agriculture Nutrition and Development, 7*(4), 1–13.

Waithaka, K., & Chweya, J. A. (1991). *Gynandropsis gynandra (L.) Briq: A tropical leafy vegetable, its cultivation and utilization* (No. Issue 107 of FAO plant production and protection papers). Rome: Food & Agriculture Organization of the United Nations.

World Bank. (2007). *World development report 2008: Agriculture for development*. Washington, DC: Author.