Original Article

Pacific pandanus fruit: an ethnographic approach to understanding an overlooked source of provitamin A carotenoids

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Commonly recommended plant sources of provitamin A, such as dark green leafy vegetables, are not acceptable in many population groups. The objective of this study was to identify other indigenous foods that may be effectively promoted to alleviate vitamin A deficiency (VAD) and to gather information relevant to identification, production, acquisition, and consumption of foods relevant to a food-based VAD prevention strategy in the Federated States of Micronesia. An ethnographic study on edible pandanus cultivars, involving key informant interviews and observation was carried out. Analyses revealed a great range in carotenoid content. Several orange-coloured pandanus cultivars, all highly acceptable, contained high levels of carotenoid, almost meeting daily requirements in usual consumption patterns, whereas light yellow-coloured cultivars contained low levels. Availability has decreased substantially in recent years due to increased consumption of imported foods and general neglect of indigenous foods. High-carotenoid pandanus should be promoted for general enjoyment and health benefits.

Key Words: pandanus, vitamin A deficiency, food-based strategy, ethnography, Micronesia.

Introduction

This study, using an ethnographic approach, examines a little studied food, pandanus, which could play a significant role in addressing vitamin A deficiency (VAD) in some parts of the world. Pandanus is an indigenous food in the Federated States of Micronesia (FSM)[1] (Fig. 1), and has a yellow- or orange-coloured fruit known to be vitamin A-rich (Fig. 2).[2] Because of its importance, particularly on atoll islands, it was one of four foods explored in a recent literature review.[3]

It is well-established that VAD is associated with health risks, and that improving vitamin A status in deficient populations can decrease all-cause mortality by around 23%.[4] A serious problem of VAD has been identified in the four FSM states, Chuuk,[5,6] Pohnpei,[7] Kosrae and Yap,[8] and the neighbouring countries, Republic of the Marshall Islands,[9] Republic of Kiribati, and Solomon Islands.[10] Understanding indigenous foods and food systems is essential to the establishment of an effective food-based approach to alleviate VAD.[11,12]

The purpose of this study was to identify pandanus cultivars that could be effectively promoted, along with other vitamin A-rich foods, in order to alleviate VAD in a food-based VAD prevention strategy. An ethnographic approach was taken in order to gain an insider's understanding of how pandanus fit into daily food patterns and to gather relevant information on pandanus fruit identification, production, acquisition and consumption. The study took place in Kosrae and Pohnpei, but includes information from other sites. Using this ethno-graphic approach enabled the collection of important information that had been lacking in VAD studies in the past for this region.

Choice of foods to promote in a food-based VAD prevention strategy

A food-based approach to eliminate VAD has been initiated in FSM.[13] Similar to VAD prevention programs elsewhere in tropical countries,[14] it promoted dark green leafy vegetables, papaya and mango, and other vitamin A-rich foods. However, green leaves have not been eaten in the past on many FSM islands and are often considered as animal food.[15,16] Papaya and mango are often eaten in the green carotenoid-poor stage. Ripe papaya is often thought of as pig food.[17]

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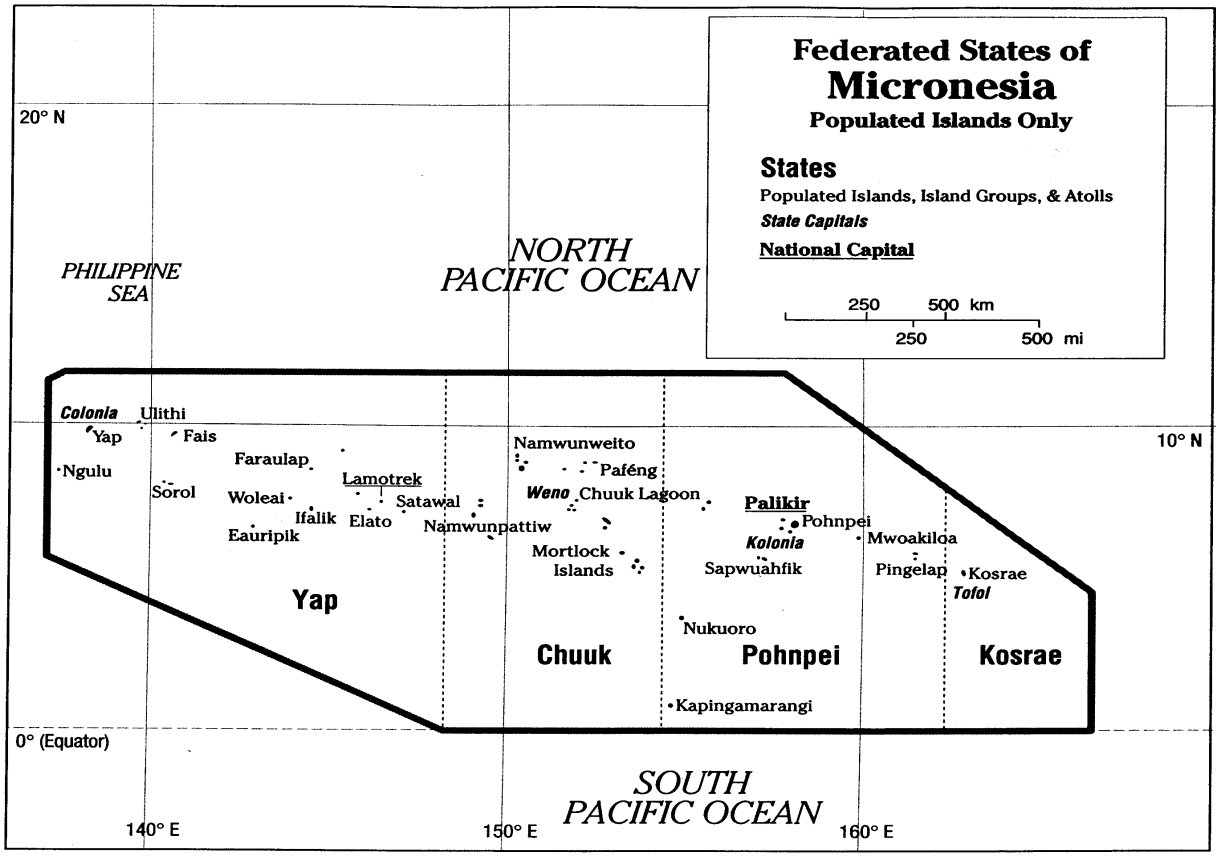

Figure 1. Map of the Federated States of Micronesia (Close Up Foundation 2000)

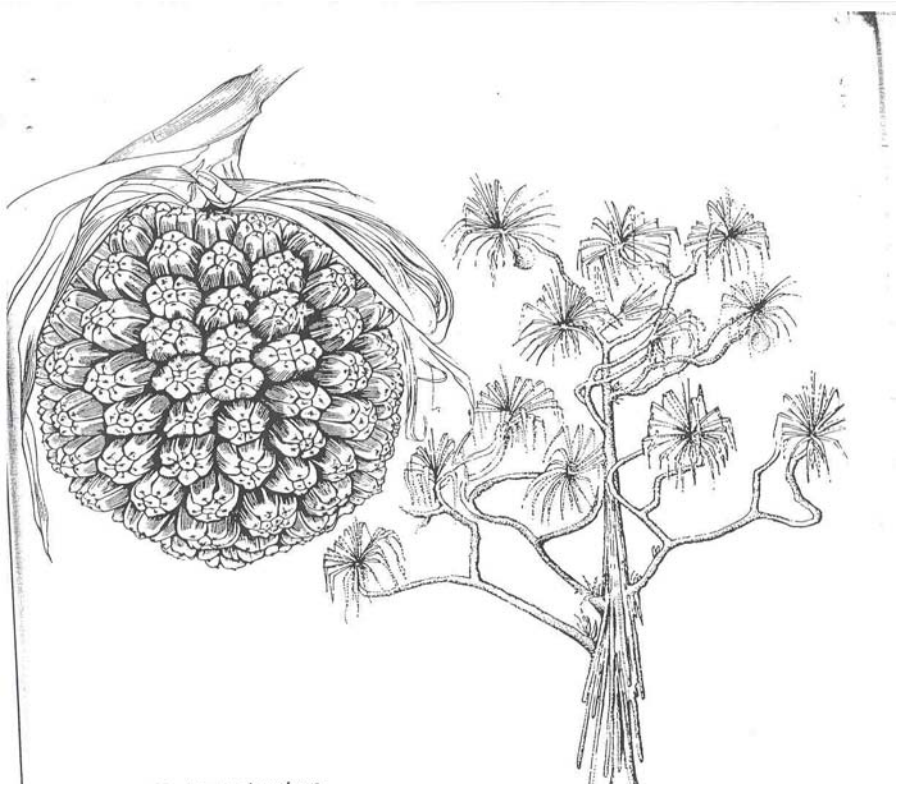

Figure 2. Illustration of pandanus tree and fruit [20]

Some highly acceptable FSM staple foods, including banana, breadfruit, and giant swamp taro cultivars, have recently been identified as vitamin A-rich[18] and programs have been initiated for promoting these foods for alleviating VAD.[19]

An additional vitamin A-rich food that has often been overlooked is edible pandanus, *Pandanus tectorius*. A distinction should be made between this and other pandanus species, including those eaten for the seeds, not the fruit.[20,21] Because pandanus withstands sandy saline soils and the low rainfall of atoll islands, it is among the only foods that can grow on these islands.[22-25]

Consumption of pandanus

Pandanus is an important food on certain Pacific islands, particularly the atoll islands of the Marshall Islands, Kiribati, and some FSM islands, especially Kosrae, and the Pohnpei atoll islands of Kapingamarangi, Nukuoro, Mokil, and Pingelap.[1,21,22,25-29] Pandanus is also grown and eaten on islands of Pohnpei,[30] Chuuk,[31] Yap,[32] Solomon Islands,[33] and Papua New Guinea.[20, 21]

Pandanus is a multiple fruit, sometimes referred to as a bunch, and is made up of smaller sections called keys.[26] These have an outer hard part, and an inner soft fibrous part that is chewed, sucked, and/or eaten; a few cultivars have a small edible seed in the outer part. Not all pandanus fruit are edible, some having oxalate crystals producing mouth irritation. Edible cultivars are grown by cuttings, but revert to inedible cultivars if allowed to grow by seed. The fruits of the many pandanus cultivars are distinct in size, shape, colour, flavour, and juiciness.[2,22]

Review of past papers reporting on nutrient content of pandanus

There are five past studies that report on pandanus nutrient content, most finding low content.[18,34-37] Only one previous study of the 1950s provides data on carotenoid content of different pandanus cultivars.[34] A study, which was part of this study, involving five Kosrae cultivars, indicates that orange-coloured keys contain significant levels of provitamin A carotenoids, light yellow keys containing low levels.[38] This is biologically plausible, as yellow and orange colouring is characteristic of carotenoid compounds.[39] The 1950s study, carried out by a Hawai'i team, analysed two raw Marshall Islands pandanus cultivars, finding one cultivar with high carotenoid content (1242 μg carotene) and one with low (184 μg carotene).[34] Although key colour was not specified, the cultivar with low carotenoid content was *joibeb*, which appears to be the same as (or very similar to) the Kosrae cultivar *choipep* (the names are linguistically derivative and informants report that it was introduced from the Marshall Islands). *Choipep* has a light yellow colouration (and low carotenoid content[38]), giving further strength to the premise that deeper colour in pandanus indicates higher provitamin A carotenoid content. The Pacific Food Composition Tables present only one entry for pandanus fruit. They give 714 μg/100g[40] as the provitamin A carotene content, apparently the average of the values of the two cultivars studied in the 1950s. This value does not reflect cultivar differences, and implies that all pandanus cultivars contain high levels of provitamin A carotenoid.

Materials and methods

The study was carried out in Kosrae and Pohnpei, FSM, as part of an overall study to identify vitamin A-rich foods and used ethnographic methods selected from guidelines developed for studies of this type.[11,41,42] Approval for the research was obtained from the University of Queensland Medical Research Ethics Committee and from the local FSM National Heath Research Committee. The focus was on identifying foods that may be vitamin A-rich, determining pandanus cultivars to be analysed, and collecting information needed for developing an effective food-based intervention strategy, including data on pandanus identification, production, acquisition, and consumption.

The lead author spent thirteen weeks in Kosrae, spread over October to November 2000, and January to October 2001. The study involved key informant interviews of men, women, market owners, farmers, government officers, young and old people, and informal focus group discussions, observations, and photography. Free listing was used to ask informants to grade cultivars according to the greatest colouration of the edible portion, to identify tasty cultivars, and to list cultivars for characteristics such as sweetness and size. Relevant documents were reviewed to aid in the search for cultivars. Interviews were also conducted in Pohnpei with key informants from Pohnpei atoll islands, and from Chuuk and Yap, in order to gather information on pandanus eaten in other parts of FSM.

Results and Discussion

Quantity eaten and impact on vitamin A requirement

Depending on fruit availability and personal tastes, adults might eat 20-50 pandanus keys daily. A calculation for provitamin A carotenoid in pandanus shows that a non-pregnant non-lactating woman could obtain almost her total daily vitamin A requirement of 500 μg Retinol Equivalents[43] if she consumed in a day 20 keys weighing 65 g/key of the *masal lulap* cultivar, using the newly advised conversion factors, 12:1 for β-carotene and 24:1 for α-carotene.[44] Murai (1958) found that one year-old children might eat ten keys in a day, potentially providing over three-fourths of their daily requirement for vitamin A of 300 μg Retinol Equivalents.

Kosrae pandanus cultivars

Table 1 presents the Kosrae pandanus cultivars, carotenoid content, and other descriptive information, including colouration of the edible portion of the fruit. (See Englberger *et al.*[38] for a description of the methodology and results of the HPLC analysis of the Kosrae pandanus cultivars for α- and β-carotene.)

Table 1. Names, carotenoid content, and descriptions of cultivars of Kosrae pandanus fruit *Pandanus tectorius*

Local name	β-carotene[1] µg/100g	α-carotene[1] µg/100g	Colour of ripe key	Availa-bility	Sold	Key size[2] & shape	Bunch size[3]	Taste[4]	Ripening[5]	Other
Mweng masal sriksrik	393	157	Orange	Common	Yes	Small, narrow	Large	Very sweet, juicy	Ripe keys fall off bunch	Taste different to masal lulap; tree bears fruit close to ground
Mweng masal lulap	334	190	Orange	Common	Yes	Large	Large	Sweet, Less juicy	Ripe keys fall off bunch	Taste is similar to choipep; tree bears fruit close to ground
Mweng masal srisrik (new)	211	67	Orange	Less common	Yes	Small	Large	Very sweet	Ripe keys fall off bunch	Has only recently been introduced
Mweng oa	87	24	Yellow	Rare	No	Small	Small	Less sweet, fibrous	Ripe keys fall off bunch	Now less well-known
Mweng choipep	19	<2	Light yellow	Common	Yes	Medium Short,	Medium	Sweet, juicy, crunchy	Ripe keys don't fall off bunch	Most well-known, popular, more flesh to eat
Mweng kaki†	na	na	Orange	Very rare	No	Squarish	Medium	Not so sweet	Ripe keys don't fall off bunch	Has an edible nut eaten raw, less edible fruit, uncul-tivated
Mweng fien fol†	na	na	Orange	Rare	No	Medium	Small	Sweet, juicy, spicy taste	Ripe keys fall off bunch	Has special spicy mint-like taste, soft flesh, tall tree

† No samples were obtained, due to great rarity and seasonality. [1] Samples analysed by HPLC, July 2001, University of the South Pacific, Suva, Fiji [18]
[2] With inedible end removed: small key ~30 gram ; medium key ~60 gram; large key ~100 gram. Whole key: length 3-5 cm long; 5-10 cm in diameter.
[3] Small bunch ~8 kg; medium bunch ~ 10 kg; and large bunch ~15 kg; [4] Pandanus has a distinct taste in comparison to other fruits, and different cultivars have distinct tastes; cultivars also vary in sweetness and texture. [5] Pandanus cultivars differ in ripening, some with keys falling off bunch, some not.

Pandanus is available year-round on Kosrae, different cultivars ripening successively. Three pandanus cultivars were introduced from the Marshall Islands. Two cultivars, *mweng fien fol* and *mweng oa*, were named as original Kosrae cultivars, and appeared on an early pandanus cultivars list,[27] along with nine others. Both are now rare. No *mweng fien fol* could be obtained, despite an extensive search including radio announcements offering payment for samples. No sample was found of *mweng kaki*, an uncultivated pandanus, prized previously for the seed found in the outer part of the key and eaten raw.

***Pandanus*-related food behaviour**

Chewing pandanus was considered not only a matter of eating, but a social activity. One informant explained that she ate pandanus as entertainment. Pandanus was never eaten at mealtime. One informant explained how the Kosraean language describes the activity of consuming pandanus as different from normal eating. One is said to "wiwi mweng" (chew pandanus) and not to "mongo mweng" (eat pandanus). One Kosrae informant explained that pandanus is a food that sick people eat in order to feel better although most people including health workers were not aware of its health benefits or provitamin A content. A few indicated that pandanus is good for the teeth, due to the chewing involved in its consumption. Testimony that pandanus is popular is provided by the fact that Kosrae people indicated difficulty in getting the harvest from their own pandanus trees. One informant explained that she and her family often harvested their pandanus very green, although it would taste better if left to ripen longer on the tree. If they did not harvest early, she said that others would take the fruits off their trees for themselves, and that this had often happened to them.

In Kosrae, pandanus is only eaten raw. A nutrition educator explained that she had given demonstrations on cooking

pandanus, but that the custom had not been taken up. One woman explained that she heard that one should never eat the pandanus cooked, as then the fruit from that tree would revert to being inedible. Kosrae has mostly a subsistence agricultural system and families generally eat produce that they grow themselves. However, pandanus are sold at small local markets, either as whole bunches costing from US$5-10, or as individual pieces costing US$0.10/piece or US$1 per bag of 10 keys. Pandanus were occasionally marketed at the airport, cut into edible pieces and sold at US$0.50/3 pieces.

Pohnpei pandanus cultivars

Pohnpei Island and Kosrae are rural mountainous islands, not atolls; yet there are distinct differences in the agricultural crops. In contrast to Kosrae, pandanus is not a major food in Pohnpei, appearing not to grow well there.[45] There are two names used in Pohnpei for pandanus, *deipw* and *kipar*, with people from the different parts of the island using different terms. Many key informants from Pohnpei were not aware that there were two terms for pandanus used on the island (the distance across the island is around 39 kilometers). There is no distinction between cultivars.

Outer island Pohnpei cultivars of pandanus

Table 2 presents the pandanus cultivars of the Pohnpei atoll islands, and descriptive information including colouration. On the outer atoll islands of Pohnpei, pandanus production and consumption is common and specialized. When asked about pandanus cultivars grown and eaten on Kapingamarangi, key informants listed 17 cultivars by name that had both orange and yellow-coloured keys, two that had only orange keys, and one that had only yellow keys. The orange keys were smaller. In Kapingamarangi, there were separate terms for the plant, the bunch, the key, and the ripe key. However, use of pandanus was decreasing; it was explained that they no longer dry and pound ripe pandanus for the powder, which used to be made into a type of pudding, as people rely now on imported foods. It may be significant that Kapingamarangi is a 'Polynesian outlier', as Polynesians settled that island in early migrations, which indicates that further analysis and possible use of edible pandanus in Polynesia should be investigated.

In addition to the 13 edible Nukuoro pandanus cultivars, there were 20 others used for weaving or for wood. The key informant indicated that people from Nukuoro had introduced pandanus cultivars from Nukuoro to Pohnpei, but that the fruits did not taste as good as when grown on their atoll island. For Pingelap, a list of pandanus cultivar names prepared by St. John (1948) was used to help identify pandanus cultivars. Of 14 cultivars listed, 10 were recognized by the Pingelap key informant; one cultivar was noted to have no flower or fruit, one was previously listed twice with a suspected spelling error, and two appeared to be no longer grown in Pingelap. In Mokil, some cultivars were noted as especially good for boiling and subsequent eating. All informants indicated that there were additional new pandanus cultivars having no names, and that some names were group names with a number of sub-types. Although there were three to four different reported pandanus cultivars in Sapwuahfik, there were no separate cultivar names.

Chuuk pandanus cultivars

Chuuk key informants reported two pandanus cultivars, "fach" and "in fach" for the main island and lagoon islands, but several for different atoll islands. The cultivar "in fach" was a wild inedible pandanus, causing mouth irritation upon eating, although some did eat it. A key informant from the Mortlock Islands of Chuuk described four different pandanus cultivars, two with yellow-coloured fruit and two with orange-coloured, but he did not know the cultivar names. People in the western islands of Chuuk refer to pandanus as "far", which is their pronunciation of pandanus "fach". Merlin (1996) documents six edible cultivars recorded for Puluwat and two for the Chuukese outer islands of Namonweito, Murilo, and Nomwin.

Yap pandanus cultivars

On the main island of Yap, pandanus (*choi*) was not considered a food, and most pandanus cultivars were the inedible type. On the outer atoll islands of Yap, pandanus was more commonly eaten and were known as "fach" or "far" depending on the island.

Conclusions

Edible pandanus is a highly acceptable fruit on many rural Micronesian and some other Pacific islands and has held a special place in the diet, particularly as a snack food, for many people in the past. Yet, due to increased reliance on imported foods, pandanus fruit availability and consumption has decreased substantially in recent years. Thus, pandanus cultivars high in carotenoid content should be promoted both for their general enjoyment and for health benefits and alleviating vitamin A deficiency. It appears that the deeper orange colour of the edible portion of the pandanus key may be used to identify cultivars with high carotenoid content, which could help people to identify cultivars most likely to have the greatest health benefits. Further studies are needed to verify this.

Special emphasis should be made on promotion of high carotenoid pandanus on atoll islands, due to the limited number of foods that grow there, problems of food security, and its high acceptability as a local food. Consideration should be given to the introduction of high carotenoid pandanus cultivars on islands not having them in the past, but this should only be done following investigations of potential for production and acceptability. As noted, the introduction to a community of less-acceptable foods, such as dark green leafy vegetables, decreases the likelihood of their being incorporated into the diet, even when they might address serious, well-recognized health concerns.

Finally, an ethnographic approach is an effective way to identify carotenoid-rich cultivars of local foods suitable for promoting in a food-based approach to improving nutritional status. This approach helped us to understand pandanus in its cultural and environmental context and provided information

Table 2. Names and descriptions of cultivars of pandanus fruit *Pandanus tectorius* from the outer atoll islands of Pohnpei State[1]

Atoll island	Local name for pandanus	# of edible pandanus cultivars[2]	Name of cultivars described to have yellow-coloured edible portion	Name of cultivars described to have orange-coloured edible portion
Kapingamarangi	Binu[3]	20*	Binu daalinga, binu dolongahai[5], binu waidolo, binu modu, binu tadumaangala, binu bugudee, binu taladuuli, binu hoo[5], binu hagammuu, binu luwaawa, binu tagabogia, binu talaadahi, binu madiiloo, binu hadukene, binu tokongo, binu diulungi[5], binu binu[4], binu halamobu, binu maasala	Binu daalinga, binu dolongahai, binu waidolo, binu modu, binu tadumaangala, binu bugudee, binu taladuuli, binu hoo, binu hagammuu, binu luwaawa, binu tagabogia, binu talaadahi, binu madiiloo, binu hadukene, binu tokongo, binu diulungi, binu binu[4], binu hetat
Nukuoro	Hala	13	Hala maimai[5], hala maasonga[5], hala seuebuebu[5], hala kadii[5], hala aaleo[5], hala masele, and hala makili	hala benuvaidolo, hala modumodu[5], hala modu[5], hala vaii[5],hala moobu[5], hala bendalinga[5]
Mokil	Kipar	13	Suwiapwepw[4], nehnkehtak, insohl, deipw[5], oarwehn, moakuskus, oarwehn pen paso	sipwerik, doapwoatin, luarmwe[4], mehkilkil, joanmonoia, mangoaron,
Pingelap	Kipar	10	nanakaisak, aisesewil, mau kosokosok, es ies[5]	Asipuirek, sonmeneia, suweibueibuei, muisamuis, arawan, luaramuk
Sapwuahfik	Kipar	3-4**	-	-

[1]Names of cultivars obtained by interviews on Pohnpei Island with key informants from the particular atoll island; [2]Number of cultivars includes those given names. [3]Pinu refers to the pandanus tree. Other terms were: hala for the bunch, huwaahala for the key; teleheewu for the ripe key; [4]Name is a group name: Binu binu said to have 10 types, mostly not sweet, and not named separately. Others had two types each. [5]Cultivar which had a small edible seed in the key, some obtained by biting key open, others obtained by cutting key open with a knife. *Number includes the total of names of cultivars, most which also have two types, one with yellow-, one with orange-coloured edible portion. ** There were 3-4 types of pandanus, but no names for the different cultivars.

that might not otherwise have been obtained. A combination of qualitative and quantitative research is required to provide all the information needed for the identification of carotenoid-rich local foods and for developing effective and acceptable food-based intervention strategies.

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